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THESIS

VALIDATION OF AN ACTIVE MULTIMEDIA COURSEWARE PACKAGE FOR THE INTEGRATED DAMAGE CONTROL TRAINING TECHNOLOGY (IDCTT) TRAINER

by

Mark S. Johnson

September 1994

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This paper reports the test and evaluation results of the Integrated Damage Control Training Technology (IDCTT) Trainer. This device -- the product of a four year advanced development effort -- uses interactive courseware which incorporates the latest multi-media computer technology to create a realistic damage control training environment. The trainer was developed to support a recent change in shipboard damage control philosophy called Total Ship Survivability (TSS); a concept which emphasizes the simultaneous repairing of a ship's combat damage while maintaining its ability to fight.

The new trainer was comprehensively evaluated using performance data and survey results collected from students and instructors during a three month test period at the Surface Warfare Officer School's Damage Control School in Newport, R.I. Findings from seven different surveys are presented; performance comparisons between the conventional trainer and this new trainer are examined; and narrative accounts of both students and instructors are reported. The data clearly identify and isolate the specific benefits as well as some drawbacks associated with the various enabling technologies integrated during the advanced development of the prototype. Recommendations about operationally deploying the device are discussed and the implications of suggested enhancements are explored.

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by

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ABSTRACT

This paper reports the test and evaluation results of the Integrated Damage Control Training Technology (IDCTT) Trainer. This device — the product of a four year advanced development effort — uses interactive courseware which incorporates the latest multi-media computer technology to create a realistic damage control training environment. The trainer was developed to support a recent change in shipboard damage control philosophy called Total Ship Survivability (TSS); a concept which emphasizes the simultaneous repairing of a ship's combat damage while maintaining its ability to fight.

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EXECUTIVE SUMMARY

Recent developments in multimedia technology have made it possible for computer generated simulations to create vivid, life-like damage control training scenarios. The Navy's damage control community – acquisition agents, trainers, and research and development managers – has explored these new technologies to produce more realistic training scenarios. One such exploration culminated in a multimedia integration of several enabling technologies collectively called IDCTT: the Integrated Damage Control Training Technology.

The Integrated Damage Control Training Technology (IDCTT) Trainer is an interactive video courseware (ICW) medium which incorporates the latest video and audio technology to provide realistic damage control training in a simulated shipboard environment. IDCTT's design goal was to provide Damage Control Assistants (DCAs) with interactive computer-based damage control scenarios that realistically showed the consequences of their damage control decisions in terms of their impact on the shipboard environment. This thesis evaluated the extent to which this interactive video courseware achieved that design goal. Specifically, it validated the effectiveness of the IDCTT Trainer as a training tool for Damage Control Assistants (DCAs) and the instructors who train them.

IDCTT was specifically designed to support DCA training, not in the conventional sense, but under relatively recent changes in shipboard damage control philosophy. The results of this doctrinal shift has been called the Total Ship Survivability (TSS) concept. Total Ship Survivability reasserts the World War II concept of simultaneously repairing combat damage while maintaining the ship's ability to fight. TSS is a training concept designed to increase a ship's war fighting capability and the IDCTT Trainer, in turn, is designed to deliver that TSS based training concept.

This paper examined two central aspects of the IDCTT Trainer's performance: its performance in and of itself, and its performance when compared to the trainer currently in use, which is called the Damage Control Central Trainer. Pinpointing these relatively circumscribed areas enabled the evaluation and the

subsequent analyses to produce sufficient data needed to quantify the impact the new integrated technologies had upon both student and instructor performance.

The test and evaluation data collection plan for the device was designed to solicit and collect student and instructor inputs, which taken together, provided a basis upon which to evaluate how well IDCTT supported DCA training. This portion of the study identified system strengths, weaknesses, and design features of the prototype which could be improved to enhance its next variant and subsequent generations of the product. Also, the measures of student and instructor reactions to IDCTT provided a basis from which to gain insights into the usefulness of the trainer as a fleet training aid. Students and instructors provided this information using short essays and descriptive narrative accounts, quantitative subjective rating data, check-off lists of problem features, formal surveys, and both structured and unstructured interviews.

A direct comparison of IDCTT with the DC Central Trainer was done to concurrently determine the relative effectiveness of both trainers. The evaluation sought to draw comparisons by obtaining student performance scores for each trainer type on a variety of comparative dimensions, and on measures of each systems' ability to produce standardized training scenarios. This information was obtained during student training sessions conducted in both trainers during which performance was carefully graded using a standardized grading protocol. Moreover, subjective impressions of user preferences were quantified using standardized rating scales designed to further compare and contrast design features of both trainers.

IDCTT's test and evaluation was conducted at the Damage Control Training Department of the Surface Warfare Officer School in Newport, Rhode Island. This school provides the only academic training for novice DCAs. Before this study, the School's only source of simulated DCA battle problem training was the conventional Damage Control Central Trainer. The new IDCTT Trainer was transported to the DCA School and installed in its simulation wing for the purpose of the current test and evaluation study.

Data were collected on three occasions. The first test period, 24 through

29 March 1994, consisted of preliminary trials designed to validate the planned data collection methodology and to evaluate the IDCTT Trainer's performance characteristics. Findings from this pilot test phase were used to modify the original test and evaluation data collection plan as well as the actual hardware configuration of the IDCTT trainer prototype itself. The validation data were collected during the second and third test periods which were conducted 19 through 21 April 1994, and 20 through 22 June 1994. Thirty-two students and seven instructors participated in the evaluation.

The validation data revealed that the IDCTT Trainer was highly effective on the majority of ' .ining dimensions specifically evaluated by the test methodology. For example, students reported that the IDCTT Trainer was easy to operate and extremely useful as a training aid at the Damage Control School. They also reported their desire to see the trainer made available for shipboard use. When the IDCTT Trainer was directly compared to the DC Central Trainer, students reported that the IDCTT Trainer was clearly the preferred training method. IDCTT promoted a more rapid acquisition of basic skills and ultimately, a higher level of proficiency. Moreover, contrasted to the conventional DC Central Trainer, IDCTT induced significantly higher levels of stress and motivated students to more actively participate in the damage control scenario. Formal statistical tests of the differences between scores from the two different trainers revealed that the IDCTT scores were in fact higher than the conventional DC Trainer's ($p < .05$).

Although students and instructors reported that the IDCTT Trainer was an effective training medium, they did identify configural and functional characteristics of the trainer for potential improvement. For example, some of these candidate changes were associated with using the touchscreen monitor to input information into the system. Fifty-nine percent of the students reported that they experienced some difficulty operating this input device. The screen's primary problem was its low sensitivity to touch and its slow response time Students recommended increasing its sensitivity or simply exploring different input methods, such as voice activation for future consideration. The

touchscreen design feature was but one of several identified by this evaluation. The present report lists other suggested modifications to the system and offers substantiation to support the need for reconfiguration in future variants.

The collective reports from both student officers and instructors who used IDCTT's technologies revealed one broad, simple finding: the trainer was as well liked by its users as it was effective, especially when compared to its conventional counterpart. As good as IDCTT was however, students and instructors freely suggested ways to make it better. The findings and recommendations contained in this report, therefore, highlight the indispensable role formal test and evaluation methodologies play in the transition of educational products from advanced development to service use.

I. INTRODUCTION

Throughout American Naval History, damage control has played a key role in the success of American warships at sea. The fundamental requirement needed to prepare for battle damage is damage control training and since it is unreasonable for ships to actually incur self-imposed damage, damage control training has come to employ simulations of battle damage situations. In the past, these scenarios were relatively crude, relying heavily upon human intensive role playing. Recent developments in multimedia capabilities however have made it possible for computer generated simulations to create life-like training scenarios. The damage control community has adopted these new technologies to produce more realistic training scenarios. One such adaptation is a multimedia package called the Integrated Damage Control Training Technology (IDCTT).

The Integrated Damage Control Training Technology (IDCTT) Trainer is an interactive video courseware (ICW) medium which incorporates the latest video and audio technology to provide damage control training in a simulated shipboard environment. This thesis addresses that interactive video courseware. Specifically, it validates the effectiveness of IDCTT as a training tool for Damage Control Assistants (DCAs) and its results will be used by the Naval Personnel Research and Development Center (NPRDC) to justify the use of the IDCTT system as a fleet training aid.

The focus of the present chapter is threefold. First, background information concerning the IDCTT Trainer and the fundamental concepts of damage control are discussed. Second, a detailed description of the new multimedia components used to create the Interactive Damage Control Training Technologies (IDCTT) Trainer is provided. A description of the user's interaction in this new medium is included in the discussion. Finally, the conventional shore based training technique in use today, the Damage Control Central Trainer, is summarized.

A. BACKGROUND

IDCTT was specifically designed to support DCA training, not in the conventional sense, but under a relatively recent change in shipboard damage control philosophy called the Total Ship Survivability (TSS) concept. Total Ship Survivability employs the World War II concept of simultaneously repairing combat damage while maintaining the ship's ability to fight. After the USS Stark (1987) and USS Samuel B. Roberts (1988) incidents, it became apparent that the damage control organization was able to repair damage necessary to save the ship but in each incident, the ship lost the ability to defend itself from further attacks. TSS is a training concept designed to increase a ship's war fighting capability and the IDCTT Trainer is designed to deliver that TSS based training concept.

The IDCTT Trainer uses information from the Battle Damage Estimator (BDE) which is a software package that displays the most probable damage to a ship after being hit with a particular weapon. Moreover, IDCTT interfaces with the Integrated Survivability Management System (ISMS),[1] which provides two dimensional graphic representations of the ship, to produce line diagram drawings of damaged areas and systems.[2] It also uses the latest laser disk video, compact disk audio, and computer technology to create a realistic training environment.

1. Damage Control Fundamentals

A basic understanding of what Naval Damage Control is and how it is conducted is needed to understand what IDCTT attempts to accomplish. Damage Control is divided into two disciplines; damage prevention, and damage containment and repairs. The IDCTT Trainer focuses on damage

[1] The ISMS system was removed from the IDCTT Trainer after initial test results revealed human interface problems which will be discussed later in the text.

[2] The Battle Damage Estimator (BDE) and the Integrated Survivability Management System (ISMS) will be described in detail later in the text.

containment and repairs. This aspect of damage control is defined as [illegible]

> [illegible] ... and localize damage when it occurs by measures such as controlling flooding, preserving stability and buoyancy, containing and fighting fires, replacing essential structures and manning essential equipment (Gritzen, p. [illegible], [illegible]).

2. Damage Control Organization

Since this thesis repeatedly refers to members of the damage control organization, this organization will be described in some detail. The following provides the reader with a general discussion of the operational damage control organization.

a. *Damage Control Assistant*

The Damage Control Assistant (DCA) reports to the Chief Engineer who is the Damage Control Officer and responsible for damage control on the ship. He also reports to the Officer of the Deck[3] who is the Commanding Officer's direct representative on all operational matters. The DCA uses repair lockers II, III, and V,[4] which are equipped with the appropriate damage control equipment and manned with 20 to 50 personnel, to combat shipboard damage. The Combat Systems Maintenance Center (CSMC) provides an interface between the DCA and Combat Systems personnel to coordinate the alignment[5] and repairs of the ship's weapon systems.

b. *Damage Control Central*

Damage Control Central (DC Central) is a command center from which the DCA coordinates shipboard damage control efforts. A support organization in DC Central assists the DCA in collecting, processing,

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[3] The Officer of the Deck stands watch on the bridge and is charged with coordinating shipboard operations and given the authority to make operational decisions in the Commanding Officer's absence. He is also required to keep the Commanding Officer informed of all pertinent shipboard matters.

[4] Repair II and III are responsible for damage control in the forward and after areas of the ship, respectively. Repair V is charged with damage control in the engineering propulsion spaces.

[5] Due to redundancies built into ships' weapon systems, there are various component configurations that can be used to make a system operational. Alignment of weapon systems refers to the selection of available components to make a weapon system operational.

analyzing and disseminating damage control information. This support organization includes Sound Powered Phone Talkers, Plotters and the Damage Control Console Operator. These jobs are described below.

1. *Sound Powered Phone Talker.* The Sound Powered Phone Talker relays messages using standard phraseology between the DCA and the other stations. These stations include Repair Lockers II, III and V, Main Control (CSMC), and the Bridge.

2. *Damage Control Plotter.* The Damage Control Plotter plots all emergencies and damage control actions taken using standard damage control symbology on the Damage Control Plates.[6] He also assist the DCA by identifying and recommending damage control actions based on an analysis of the plot on the Damage Control Plates.

3. *Damage Control Console Operator.* The Damage Control Console Operator (DCCO) monitors an alarm display panel which remotely indicates damaged systems and compartments. The DCCO also monitors the Firemain Alarm Panel and Pump Logic Diagram. This system reports firemain pressure, indicates firemain valve positions, and displays which fire pumps are operating. The DCCO can open or shut firemain valves and start or stop fire pumps from this console.

B. The IDCTT System

The IDCTT Trainer is the result of research conducted to fulfill fleet requirements for more realistic training in both the shipboard and training command environments.

> The objective of IDCTT is to provide interactive computer-based damage control scenarios to Damage Control Officer and enlisted students. IDCTT scenarios provide an interactive decision environment that show ship damage control decision consequences (Ulozas, p.1, 15 November 1993).

This technology exploits the ability of computer based training to simulate scenarios that cannot be feasibly replicated in the real world

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[6] Damage Control Plates are blueprints of the ship that the DCA uses to track initial damage and the progression of fires and flooding. Included in these plates are piping overlays which display the network of firemain, fuel, chill water, ventilation, and compressed air pipes and ducts.

for training purposes. IDCTT attempts to realistically duplicate stressful conditions that a DCA would encounter under actual battle conditions.

> Long standing research on decision making under stress suggests that those untrained and unprepared to act in these crisis environments tend to make poorer decisions than those trained repeatedly in quasi-realistic scenarios. At present, such training does not exist in the formal school context. (Ulozas, p.1, 15 November 93)

The IDCTT Trainer manipulates the stress level imposed on the student DCA by addressing six different stimulus features listed below.

- The volume of information conveyed,
- The rapidity with which information is conveyed from various sources,
- The extent to which stimuli are partially masked by extraneous ambient noise,
- The presence of distractors such as flashing video and loud audio alarms,
- The onset of unexpected status report inquiries from the ship's Commanding Officer, and
- Negative feedback from superiors for inappropriate decisions.

Since the combined effort of the ship's crew is required to fight any damage control problem (damage control problems are generally exercised while the ship is at General Quarters (GQ)),[7] training time for DCAs is limited. IDCTT enables the DCA to realistically exercise decision making skills in a worse case scenario, without effecting the ship's routine. Moreover, it provides shore commands with a more realistic training environment.

The IDCTT depends on inputs from autonomous systems to create realistic training scenarios and uses the most modern technology to display these scenarios to the user. These system inputs, hardware requirements, and methods used to implement them in the IDCTT Trainer are discussed in the following sections. The first section, "*IDCTT System Inputs*", describes how the Battle Damage Estimator (BDE) and Integrated Survivability Management System (ISMS) interface with the IDCTT Trainer.

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[7] General Quarters is the highest condition of shipboard readiness in which the entire crew mans their respective battle stations.

The second section, "*IDCTT Trainer Hardware*", describes each of the components used by IDCTT to create a realistic training environment. The third section, "*IDCTT Trainer Software*", outlines the computer program used to run the IDCTT Trainer. Finally, the section, "*IDCTT Trainer Utilization*", describes how the system is manned and operated and a brief overview of the battle problem scenario is given.

1. IDCTT SYSTEM INPUTS

The BDE and ISMS are independent systems which provide inputs to the IDCTT. The IDCTT Trainer uses these inputs to provide outputs in the form of user training scenarios. The BDE provides the information necessary to compose accurate training scenarios that reflect the most probable damage for various weapon hits. The ISMS, although an independent system, interfaces with the IDCTT hardware to provide various information directly to the system. These two subsystems are described more fully below.

a. *Battle Damage Estimator(BDE)*

The BDE was developed on a personal computer to display probable shipboard battle damage, based on a model called the Ship Vulnerability Model (SVM).[8] The BDE enables a user to choose a weapon from a menu of eight types,[9] and an impact point on the ship. Using these two inputs, the BDE then provides damage estimates for the specific weapon chosen at the specified hit location. This estimate includes a three dimensional image indicating all spaces that would be flooded or on fire.

> Further damage information is provided in seven areas: (1) hull, mechanical, electrical and combat systems, (2) crew, (3) firemains, (4) chill water mains, (5) electrical power panels and cable runs, (6) high pressure air mains, and (7) low pressure air mains (David

[8] The Ship Vulnerability Model was developed by the David Taylor Research Center with support from Naval Sea Systems Command to provide extremely detailed models of the probable damage caused by different conventional weapons on a combatant ship. This model is based on actual weapon hit data from the Gulf War and shock test data obtained from various types of weapons.

[9] Weapon types include Exocet, Harpoon, Stinger, cruise and surface to air missiles, contact and influence mines as well as projectiles.

Taylor Research Center Ship Structures and Protection Department, p.2, June 1992).

Information generated by the BDE is used to develop training scenarios which are then used by the IDCTT Trainer. Using the BDE allows scenarios to be developed from a standardized data base of probable ship damage, thus eliminating the developers' need to approximate what damage might occur based on personal opinion. BDE output used to develop training scenarios has been successfully demonstrated by the Afloat Training Organization (ATO) TSS drills during Refresher Training (REFTRA) since 1987. The ATOs use the Total Ship Survivability/Fleet Training Model, a model similar to the BDE and also based on the SVM, to provide damage estimates for conventional weapon hit scenarios.

b. Integrated Survivability Management Systems (ISMS)

ISMS is a NAVSEA project designed to meet the information, communication, and command and control needs imposed on DCAs by the added complexity of state of the art ships and TSS responsibilities. The goal of ISMS is to provide more information to the DCA in a clear compact form. Specifically ISMS helps the DCA by:

- Determining the type and location of weapon effects,
- Communicating this information to decision stations,
- Displaying the information,
- Integrating the information with the ongoing activities,
- Developing plans of action,
- Initiating commands, and
- Executing the commands by merging traditional, survivability efforts with improved communications and computer support (Naval Sea System Command, p.1, 1992).

The ISMS, which is run on a Sun SPARC 10 computer, was integrated into the IDCTT system to provide students with all DC plate and piping overlay information. Prior to the ISMS system, this information was

[1] The Afloat Training Organization (ATO) is a shore installation which embodies officer and enlisted training experts. The ATO is responsible for training ships in various mission areas and quantitatively grading their performance during Refresher Training (REFTRA). REFTRA is a periodic 18 month training requirement where ships undergo intensive fundamental training on all aspects of surface warfare.

depicted on laminated blueprints to which the DCA would refer for information. ISMS now enables students to zoom in on any portion of the ship enabling them to obtain exact compartment, access and valve number information. IDCTT also updates the computer generated damage control plates with red and blue shadings to clearly indicate fire and flooding, respectively. Finally, ISMS uses damage reports from the user's inputs to the IDCTT to update damage control efforts in each affected space using standard damage control symbology.

2. IDCTT Trainer Hardware

The IDCTT Trainer integrates the latest multimedia hardware to produce damage control scenarios that simulate the shipboard conditions a DCA would actually face in the event of shipboard damage. The system combines a personal computer, monitors, laser disk, printer, CD rom, speakers, and a Sun SPARC 10 workstation to fully emerse the user in a realistic simulated shipboard environment. These components and their application are described below.

a. IBM Compatible Personal Computer

A 486 IBM compatible personal computer is the hardware basis of the IDCTT system. This computer provides the scenario event time line and updates the training scenario based on student inputs.

b. Computer Monitors

The system uses a 21 inch touchscreen monitor and two 15 inch monitors. The 21 inch touchscreen monitor is the input device for student orders pertaining to specific damage control actions. These orders are displayed in a menu of damage control options used by the student to combat the damage. The monitor's upper left portion depicts reports from various DC Central watchstanders that the DCA receives throughout the scenario.

The two remaining 15 inch monitors are used to provide a Damage Control Alarm Panel and a Firemain Alarm Panel and Pump Logic Diagram. The Damage Control Alarm Panel alerts the user when space alarms

have been activated. The Firemain Alarm Panel indicates system pressure, firemain value position (opened or closed), and fire pump operations (on or off).

c. Laser Disk Player

The laser disk player is used to provide video images to the touchscreen monitor. These images graphically depict shipboard personnel providing information to the DCA and subsequently, personnel relaying orders from the DCA to the appropriate crew members.

d. Printer

A laser printer receives preprogrammed graphic output from the personal computer providing the user with Damage Control Chits.[11] These chits are printed out and available for the DCA to review as a backup to the voice reports received over the Command and Control Monitor.

e. CD Rom

The CD rom provides all scenario audio inputs not included in the laser disk output such as alarm sirens, and background noise.

f. Speakers

The speakers used in the IDCTT system provide stereo sound from two separate input sources. The laser disk player provides scenario audio inputs while the CD Rom simultaneously blends background noise to create a realistic audio facsimile of a shipboard locale.

g. Sun SPARC 10 Workstation

The Sun SPARC 10 Workstation hosts the ISMS system as. This system is connected to the personal computer through a one way interface from the personal computer to the ISMS system. The ISMS system's graphical representations are updated based on the scenario event time line received from the personal computer.

[11] Damage Control Chits are hand written notes used in the fleet to communicate between the DCA and various personnel. They provide information on damage location and efforts to contain and repair the damage.

3. **IDCTT Trainer Software**

The IDCTT scenario is written in the object computer language "Quest". The program uses a next event time advance mechanism called the "event-scheduling approach".[11] This prototype software was developed by the Center for Interactive Media (CIM).[12]

> The computer program's design goal was to develop an automated, test question derived model for designing comprehensive, test performance driven, remedial instruction which alternately tests and instructs until mastery is complete (Surface Warfare Officer School Command Report, *Problem Description and Needs Justification for Interactive Damage Control Training Module*, p.3. 4 February 1993).

4. **IDCTT Trainer Utilization**

The IDCTT Trainer was assembled next to the existing DC Central Trainer at the Damage Control School. This provided the Damage Control School with a computer based training medium unlike any training method previously used in the damage control community. To understand how the school implemented this system, a familiarization of how the system is manned, operated, and what the battle problem scenario entailed is desirable. These topics are addressed below.

a. Manning

The IDCTT Trainer was designed to be operated by one or two users. When operated by a *single user*, the user assumes the role of a DCA who must perform all plotting responsibilities. When *two users* operate

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[11] The event scheduling approach to simulation modeling is a method where future events are explicitly coded into the model and are scheduled to occur in the simulated future (Simulation Modeling and Analysis, p.12, 1991). The simulated future is the models best approximation of what would happen in the real future, given a specific set of circumstances. For example, if a valve is ordered closed, the program acknowledges the order and schedules the valve to be closed at clock time plus a previously programmed delay time representing the action of physically closing the valve.

[12] CIM, an interactive media research facility located in Bethesda, Maryland, developed the software for the IDCTT. This software development was in direct support of training requirements established by the Naval Personnel Research and Development Center and the Naval Sea Systems Command. CIM gained expertise in developing interactive software through its ground breaking work on the Computer Aided Medical Information System (CAMIS), a program used to train medical students in operating room and triage procedures.

the IDCTT Trainer, one assumes the role of DCA; the other assists as the plotter.

(1) One User. When one user mans the system, that person monitors all alarm panels, voice reports, and printed DC Chits. Simultaneously, the user must input orders to the Command and Control Console and locate damage control information from the ISMS or DC Plates. The most time consuming action for the single user is locating valve, bulkhead, fitting, and compartment numbers from the ISMS or DC Plates, actions normally done by a Plotter.

(2) Two Users. With two users assigned, there is a convenient division of duties: one user takes command as DCA; the other assists as a Plotter, providing the appropriate information from the ISMS or the DC Plates. For this study, teams of two persons were assigned to the trainer. *This will be discussed more fully in the methods section.*

b. Operation

The program is initiated using a start option on the Command Console menu screen. The DCA has the option to select essential watchstanders and stations from the Command Console menu from which he can request information or direct action. Once a watchstander or station is selected, a second menu replaces the previous one with a list of options that the watchstander or station can perform. This process can be repeated until the desired action a student wishes to order is displayed on the menu. When an action is chosen, the computer generated audio visual representation of the appropriate DC Central watchstander back the information the DCA has ordered and relays it to the appropriate station.

All student inputs to the system (orders) affect the simulation event time line. When an order is given, the required action is scheduled into the future. Some events, such as the mine and missile hits, are programmed to occur regardless of the user's actions. This process provides each student with the same baseline scenario, but

significant variation in the scenario is induced depending on the user's actions.

c. IDCTT Scenario

The IDCTT scenario starts with the ship going to General Quarters. During this evolution, material condition Zebra[14] is set throughout the ship which the DCA monitors and reports to the Bridge. After condition Zebra is set, the ship takes a mine hit aft of the after Vertical Launch System (VLS) Magazine.[15] The mine hit produces fires adjacent to the aft VLS Magazine, flooding below the waterline, and shock damage to various systems. Depending on the actions taken by the DCA, the damage may spread, be contained, or repaired.

After the DCA has had approximately seven minutes to respond to the mine damage, an Exocet missile impacts the ship forward of CIC on the 0-1 level.[16] The missile inflicts a rupture to the chill water system that renders the radar system inoperative and causes various fires in the vicinity of the blast. Similar to the mine hit, damage may spread, be contained, or repaired depending on the DCA's actions.

d. Kill Points and Pitfalls

The IDCTT Trainer scenario uses "kill points" to terminate the training evolution when it is determined by the software that the student's actions would result in a complete loss of the ship. For incorrect actions with less severe consequences, the program uses

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[14] Zebra is the code name used to describe the highest material readiness condition a ship can maintain. In condition Zebra, all water-tight doors and hatches are closed to prevent progressive fire spread and flooding in the event of damage. Further, key valves are closed in piping systems, thus breaking them into smaller systems, to prevent damage in one area from effecting the entire system.

[15] The VLS Magazine contains the ship's anti-air and anti-submarine missile inventory. There is one VLS Magazine located in the forward and after areas of the ship.

[16] 0-1 level indicates the first deck above the main deck. Continuing this standard numbering system, the 0-2 level is the second deck above the main deck.

"pitfalls" to warn the student that an inappropriate action was taken. "Kill points" and "pitfalls" are described below.

(1) Kill Points. The IDCTT Trainer has five distinct kill points which will terminate the program. Kill points are activated by poor or untimely DC efforts or a misunderstanding of the basic DC concepts necessary to complete scenario. These five kill points are:

- The fire consumes a majority of the ship,
- The Aft VLS Magazine exploded,
- Chill Water distribution is completely lost,
- Vital cabling trunk is lost, and
- The VLS Magazine is flooded without CO's permission.

When a program is terminated due to kill point activation, a message is displayed on the Command and Control Console specifying which kill point was responsible and the actions taken or neglected that caused its activation.

(2) Pitfalls. The IDCTT Trainer responds to improper decisions with negative responses. Four conditions cause a message to appear that indicates the DCA committed an error or made a poor decision. The four pitfalls are:

- The Bridge prompts DCA for a Zebra report,
- The Chief Engineer informs the DCA that he must obtain permission prior to starting a fire pump,
- The Commanding Officer orders a status report, and
- The repair lockers query an incorrect or unreasonable order.

5. Summary

The IDCTT Trainer provides students with a fast paced electronic training medium that stresses the damage control fundamentals necessary to complete a TSS based battle problem. The scenario provides students the opportunity to exercise damage control concepts taught in a simulated shipboard environment. Stressful conditions that students face while performing their job as DCA aboard a ship are realistically replicated. In the past, this training was provided by the school's conventional DC

Central Trainer. The fundamentals of the present, DC Central Trainer method, are outlined below.

C. PRESENT DAMAGE CONTROL TRAINER TECHNIQUES

Team trainers[*] and simulators provide DCAs with experience in shipboard damage control before they report aboard ship. The Damage Control Training Department currently uses trainers and simulators to prepare prospective DCAs for scenarios they may encounter in the fleet. The trainer used to teach these scenarios is called the DC Central Trainer. Seven different lesson topics are taught to each DCA class and reinforced through practical problems using the DC Central Trainer. These topics include:

- Basic DC Central Concepts Simulator,
- Stability DC Central Simulator,
- Major Underwater Hull Damage Simulator,
- Main Space Fire Simulator,
- Chemical and Biological Warfare Defense Simulator, and
- Radiological Defense Simulator.

Given that the DC Central Trainer is currently in use by the School, it provides an established baseline against which to compare the IDCTT Trainer's performance. To understand the DC Central Trainer method, a description of its objectives and an overview of its implementation at the Damage Control School are summarized below.

1. DC Central Trainer Objective

For each training scenario, students spend one to two hours in the DC Central Trainer combating various subsets of problems. Prior to commencing the first simulator training period, a 90 minute classroom instruction period familiarizes students with the equipment and concepts of simulator team training.

[*] Team trainers are often used in the Navy to train an individual for a specific whatchstation in a group environment that simulates shipboard routine and special evolutions.

Each scenario has the same enabling and terminal objectives. The enabling objective states:

> In the DC Central Trainer, PERFORM the duties of one of the following personnel during a major Damage Control scenario.
> a. DCA
> b. Plotter
> c. Sound Powered Phone Talker (Naval Education and Training Command, *Surface Warfare Officer Damage Control Assistant (A-4G-0020) Course Curriculum Outline*, p.4-20, April 1991).

The terminal objective states:

> In the Damage Control Trainer, DIRECT the DC organization during General Quarters and other emergencies by interpreting and solving Damage Control Problems. ((Naval Education and Training Command, *Surface Warfare Officer Damage Control Assistant (A-4G-0020) Course Curriculum Outline*, p.4-20, April 1991).

The DC Trainer was originally developed as a non-computer based method for meeting the enabling and terminal objectives stated in the Course Curriculum Outline.

2. DC Central Trainer Implementation

Through years of use and modification, the manning and operation of the DC Central Trainer has become standardized and only slight modifications to these aspects of the trainer were necessary to implement the TSS based scenario.[18] Unfortunately, since the DC Central Trainer's scenario inventory did not contain a multiple weapon hit TSS based scenario, the development of a scenario that could be used for direct comparison with the IDCTT Trainer was dictated. A TSS based scenario was developed by the author and approved by the Damage Control School for use in the curriculum. The scenario provided a direct way to compare the two trainers. Table 1 shows the similarities and differences between the IDCTT and DC Central Trainers. The key issues of manning, operation, and the scenario specifics are described below.

a. Manning

The DC Central trainer was designed as a group trainer to provide students the opportunity to perform each watchstander's duties in

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[18] The DCCO position was given added responsibility due to the unique damage control organization aboard an DDG-51 Class Destroyer.

DC Central. A typical DCA class is divided into groups of five to seven students. Every group performs each of the seven training scenarios once. Within the group, members rotate through the different watch stations. The DC Central Trainer accommodates a DCA, Plotter, DC Console Operator, and two to four Sound Powered Phone Talkers[19] depending on the size of the group. This arrangement enables each group member to play the role of DCA

TABLE 1: COMPARISON OF SYSTEM TRAINING FACTORS FOR THE IDCTT AND DC CENTRAL TRAINERS

Training Factors	**IDCTT**	**DC Central Trainer**
Number of operators	One or two	Five to seven
Kill Points	Same as DC Central	Same as IDCTT
Pitfalls	Same as DC Central	Same as IDCTT
Scenario Duration	Approximately 25 minutes	Approximately 90 minutes
Instructor monitoring	Directly monitors student actions	Physically removed from student, monitors student verbal inputs
Instructor's ability to assist student	Limited to explaining what the IDCTT is expecting	Able to change scenario to fit students needs
Student inputs	Drop down menus provide students with option selection	Students can order any actions, feasible or not
Scenario complexity	Same as DC Central	Same as IDCTT
White noise used to distract students	Significant amounts	None
Speed student must process information	Fast	Slow

for at least one scenario. Although students rotate through the various watchstations during the six week course, student groups only had one exposure to the DC Central Trainer's TSS scenario.

[19] Sound Powered Phone Talkers can consolidate or separate phone lines to support two, three or four Phone Talkers.

b. Operation

Before starting a DC Central Training session, the instructor assigns group members to specific watch stations. The DCA then takes charge of his watch team, directs equipment and phone checks, sets up the DC Plates and prepares for the scenario to begin. The DCA positions himself as if he were in DC Central with easy access to the alarm panels, DC Plates, and Phone Talkers. The Damage Control Console Operator (DCCO) sits at the Damage Control Console while Phone Talkers man various sound powered phone lines.

The instructor provides all inputs to the watch team using a scripted scenario. These inputs are physically displayed on alarm panels which indicate fire, flooding, changes in firemain pressure, halon, and carbon dioxide release, opening of magazine sprinklers and the onset of high temperature alarms. Furthermore, the instructor simultaneously plays the role of all watchstations which are based outside of Damage Control Central. These roles include the Captain, Bridge, Repairs II, III and V, Combat Systems Maintenance Central (CSMC), and any other stations necessary to support the scenario. In the present format, instructors must monitor two or more sound powered phone circuits and the 21 MC[20] while indicating damage through a remotely operated alarm control panel.

The DCA receives damage information through the Sound Powered Phone Talkers, alarm panels, and the 21MC. As discussed above, all information the DCA receives is generated by the instructor. The Plotter uses laminated DC Plates to assist the DCA by plotting all the information received and actions taken to combat the damage. Unlike the IDCTT Trainer, the DC Central Trainer does not have any computer display monitors or DC Chits. The system relies on "hard wired" alarm panels and

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[20] The 21 MC is a hard wired, 10 station, speaker phone system. The net includes Combat Information Center, Damage Control Central, Radio Central, the Bridge and other key locations throughout the ship.

continuous dialogue between the DCA and the instructor to maintain a continuous flow of information.

c. DC Central Trainer Scenario

Although current trainer manning levels and operational techniques did not have to be significantly modified for this study, it was necessary to develop a new DC Central Trainer scenario. *The new DC Central Trainer scenario encompassed the same learning objectives, management options, kill points, pitfalls, and emphasis on TSS concepts as the IDCTT scenario.* Since students would be exposed to both methods, scenario content had to be similar in difficulty and substance without requiring exactly the same actions needed to successfully complete the problem. In other words, if the DC Central and IDCTT Trainer scenarios were exactly the same, students would gain insight into the scenario and apply to whichever method they were exposed to last. This insight, then would confound the students' opinions and performance for the two methods.

The scenario written for the DC Central Trainer employed the same weapon types, one floating mine and one Exocet missile, as the IDCTT scenario. As in the IDCTT scenario, the ship goes to GQ and sets material condition Zebra. Unlike the IDCTT scenario, however, initial damage is caused by an Exocet missile hit forward of the after VLS Magazine. After the DCA has been given time to react to the initial damage, further damage is inflicted to the ship by a mine explosion on its port side. For the convenience of the reader, Table 2 compares the specific damage inflicted in the IDCTT and DC Central Trainer scenarios.

Similar to the IDCTT scenario, damage spreads or is contained depending on the actions taken by the DCA. If the DCA reacts poorly to the situation, the simulation will end with one of the same kill points used in the IDCTT Trainer, at the discretion of the instructor.

TABLE 2: COMPARISON OF WHEN MAJOR EVENTS OCCUR IN THE IDCTT AND DC CENTRAL TRAINER'S SCENARIOS

Scenario Description	IDCTT Trainer	DC Central Trainer
First Weapon Hit	* Fire in aft Generator Room * Loss of one fire pump and rupture to stbd firemain loop * Loss of aft radar array * flooding aft * Personnel casualties	* Fires forward of the aft VLS Magazine * Rupture to port firemain loop * Loss of aft radar array * Personnel casualties
Second Weapon Hit	* Fires on 0-1 level (above and forward of CIC) * Chill water rupture * Personnel casualties	* Fires on second deck (below CIC) * Flooding in forward compartments * Chill water rupture * Personnel casualties

3. Summary

Performance in the DC Central Trainer provides a standard for comparing and determining that of the IDCTT Trainer. Both trainers possess the same fundamental goal of training DCAs using simulated multiple weapon hit, TSS based training scenarios. The two systems differ only in the medium used to conduct this training.

II. METHODOLOGY

A. OVERVIEW

This chapter describes the methodology used in the ICW validation. The chapter is partitioned into three broad areas. The information required to conduct the evaluation is outlined first. Then secondly, the method by which data were collected at the test site is given. And third, the various statistical techniques used to reduce and analyze the data are discussed.

B. INFORMATION REQUIREMENTS

This section discusses the salient information needed to validate the effectiveness of the ICW. The validation process itself has been described elsewhere, but for the purpose of clarification, the process is defined as follows.

> *Validating the* usefulness of instructional materials involves assessing the impacts on the organization in relation to several factors. These factors can be classified into several broad categories, including:
> - Student achievement;
> - The utility, ease of use, and creativity of the materials themselves;
> - and Integration into the organization's instructional system (United States Naval Health Sciences Education and Training Command, *Interactive Multimedia Courseware Validation Report,* p.2, 3 December 1992.).

The present validation effort examined the two central areas reflected in the definition cited above. These two areas were:

- The IDCTT Trainer's performance in and of itself, and
- The IDCTT Trainer compared to the DC Central Trainer.

Focusing on these areas produced the necessary information to support a comprehensive ICW validation. These topics and the information required to support their analyses are discussed in the following sections.

1. IDCTT Trainer Performance Evaluation

The IDCTT Trainer performance evaluation was designed to solicit student and instructor inputs, which taken together, would provide a

subjective basis to evaluate the extent to which the IDCTT system supported DCA training. The focus of this portion of the study was to *identify system strengths, weaknesses, and areas which could be improved to enhance the system by modifying the prototype.* Also, measures of student and instructor reactions to this new training medium were taken to gain insight into the usefulness of the IDCTT Trainer as a fleet training aid. This information was obtained by four relatively straightforward data collection techniques. They were:

- Short essay and narrative descriptions,
- Subjective rating data,
- Check-off lists of problem features, and
- Instructor surveys and interviews.

These methods are each described below.

a. *Short Essay and Narrative Descriptions*

Short essay and narrative descriptions were solicited from students after they completed of the IDCTT Trainer training period. Respondents evaluated five dimensions of IDCTT Trainer performance in essay format. These five dimensions were:

- Problem features of the IDCTT Trainer,[21]
- The performance of the touchscreen monitor,
- Problems encountered while using the IDCTT Trainer,
- Favorable aspects of the IDCTT Trainer, and
- Aspects of the IDCTT Trainer that were least liked.

b. *Subjective Rating Data*

Subjective rating data were obtained by administering three surveys to students after they completed IDCTT training. Respondents were asked to indicate their opinion on various aspects of the trainer's performance by circling a number on an eleven point rating scale. The scale was anchored on both ends by appropriate language specific to the

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[21] This dimension provided amplification to the Check-Off problem features discussed later in the text.

actual question content and the central value indicated a neutral response. The three surveys used to evaluate this portion of the validation were the:

- *Student IDCTT Survey,*
- *User Interface Dimensions Questionnaire*, and
- *Source of Workload Evaluation*.

The *Student IDCTT Survey* was designed to obtain information on unique aspects of the IDCTT Trainer. The *User Interface Dimensions Questionnaire* was designed to provide a standard approach in evaluating eight key ICW user interface dimensions (Harmon and Reeves, 1993). Finally, the *Source of Workload Evaluation*, a technique developed by NASA, was used to assess the relative importance of six factors with regard to how much workload students experienced while operating the ICW (Hart, 1988). The three surveys appear in their entirety in Appendix A.

c. Check-Off Problem Features

After completing the IDCTT training session, students were presented with a list of IDCTT Trainer hardware and software features and asked to indicate which feature, if any, caused them difficulty. These features were generated from potential problem areas identified by the system developers at CIM.[22] The following seven features were evaluated:

- The operation of the touchscreen monitor,
- The clarity of audio reports,
- The ability to find DC Plate information,
- The acceptability of the speed or volume of information presented,
- The presentation of the Damage Control Alarm Panel display,
- The presentation and operation of the Firemain Alarm Panel display, and
- Other features not included in the survey list.

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[22] The project development team and the author compiled these topics based on their own experience using the IDCTT Trainer.

Students were invited to write about any difficulties they experienced on these items in space provided on the survey instrument.

d. *Instructor Evaluation*

After completing the training session, each instructor was interviewed and asked to complete a survey which evaluated the efficacy of the system as a training aid. The interview was open ended, allowing instructors to describe their impressions of the system and its usefulness as a shore based training aid. The *Instructor IDCTT Survey* produced ranking data and short narratives. The survey evaluated the instructors' ability to:

- Use the IDCTT system as a training aid, and
- To critique students' performance.

2. IDCTT Versus DC Central Trainer Performance Comparison

A direct comparison of the IDCTT Trainer with respect to the DC Central Trainer was done to determine the relative effectiveness of both trainers. The evaluation sought to draw comparisons by obtaining student performance scores for each trainer type on a variety of comparative dimensions, and on measures of each systems' ability to produce standardized training scenarios. This information was obtained through:

- Graded student sessions, and
- Subjective rating data.

These measures are described below.

a. *Graded Student Sessions*

Each method provided the student with the same information needed to complete the damage control scenario. Since the scenarios were designed to be equally difficult, student performance primarily depended on the medium in which they operated. A standardized scoring system was developed for assigning grades to student performance in each trainer. When compared, these scores provided a baseline measure of the IDCTT's effectiveness against the present standard; that is, performance in the DC Central Trainer.

Prior to the present study, DC Central Trainer sessions were ungraded. The Damage Control School's policy was to simply *expose* DCAs to damage control situations and not formally grade them. To facilitate quantitative basis on which to compare students' performance between the two methods, specified grading criteria were developed with assistance from instructor experts at the Damage Control School. The criteria were modeled after Fleet Exercise Publication Number 4 (FXP-4)[23] grading standards which are used to grade damage control organizations in the fleet. The grading criteria developed for the present evaluation emphasized basic damage control principles, TSS concepts, asset management, and common sense. The same grading criteria, a complete copy of which is provided in Appendix A, were used for both the IDCTT and DC Central Trainers.

b. Subjective Rating Data

Subjective rating data that compared aspects of the two systems were obtained using two separate surveys. The two surveys were the:

- *IDCTT Versus DC Central Trainer Comparison Survey*, and the
- *Scenario Topics Ranking Survey*.

The *Trainer Comparison Survey* requested students compare the two systems across eleven different dimensions. The *Scenario Topics Ranking Survey* measured students' perceptions regarding the consistency with which each trainer met the specified damage control learning objectives. These two surveys are described below and are included in Appendix A for the interested reader.

(1) IDCTT Versus DC Central Trainer Comparison Survey. After students were exposed to both training environments, they completed a survey which was designed to evaluate the IDCTT Trainer with respect to the DC Central Trainer. Eleven system characteristics were presented on

[23] FXP-4 provides Afloat Training Organizations with a grading criteria for various damage control problems while providing ships with a training guideline.

a bipolar preference scale anchored on one end by the IDCTT and on the other by the DC Central Trainer. A "six" on the scale indicated "no preference" between the two methods. Students circled the number which corresponded to the degree they felt one method outperformed the other. This item series attempted to determine which of the two systems better met the following eleven criteria:

- Simulated the shipboard environment more realistically,
- Enabled instructors to provide complete post scenario debriefs,
- Produced the greatest level of stress,
- Allowed instructors to monitor student's performance,
- Prepared the student for actual shipboard emergencies,
- Updated student inputs more easily,
- Provided scenario information closely resembling shipboard methods,
- Provided more effective teaching environment to exercise damage control skills,
- Promoted greater learning in the time allotted,
- Preferred training method, and
- Stimulated the student to perform.

Responses from this bipolar ranking series was used to determine how the two methods compared across the range of capabilities listed above.

(2) Scenario Topics Ranking Survey. The *Scenario Topics Ranking Survey* was administered after students completed each training method to measure the extent to which each trainer delivered a standardized scenario. The survey listed a series of fundamental damage control actions needed to successfully complete a damage control problem. Students rated the extent to which each fundamental topic played a role in the battle problem delivered by the IDCTT and DC Central Trainers.

The *Scenario Topics Ranking Survey* yielded two measures. First, an ordinal ranking of the 13 damage control fundamentals each scenario emphasized was made based on the median scale value from the subjective rating responses. This ranking was used to determine if the

two trainers emphasized the same damage control fundamentals, and using the median responses, to what degree. Second, the interquartile range (IQR) from each trainer's rating data was compared to determine how much the student ratings varied across the two trainers. These data highlighted the extent to which each system consistently emphasized the same learning objectives from the perspective of the student.

C. DATA COLLECTION METHODS

The IDCTT Trainer validation study was conducted at the Damage Control Training Department of the Surface Warfare Officer School in Newport, Rhode Island. This school is the sole source of academic training for novice DCAs. Before this study, the school's only source of simulated DCA battle problem training was the DC Central Trainer. The new IDCTT Trainer was transported to the DCA School and installed in it's simulation wing for the purpose of this validation study.

Data were collected on three occasions. The first test period, 24 through 29 March 1994, consisted of trials used to test the data collection methodology and the IDCTT Trainer's performance characteristics in a field environment. The second and third test periods, conducted 19 through 21 April 1994, and 20 through 22 June 1994, were used to collect the actual validation data. The three test dates were scheduled during the last week of each DCA class to ensure students had the knowledge necessary to complete complex damage control scenarios, such as those which would be presented in the IDCTT.

As discussed in the previous section, the data used in this validation was collected by a series of surveys, interviews, and graded performance evaluations. Data were collected after students completed training in each type device. Comparison data; that is, data that were ultimately used to compare and contrast the technical features of both training devices, were collected upon completion of the entire training evolution. Instructor data were collected after the student training sessions were

completed. Table 3 shows the type of data solicited at various stages of the data collection period. The following sections describe student assignments for training, survey administration, student scoring criteria, and the pilot test period used to finalize the validation methodology.

TABLE 3: DATA COMPLETION POINTS DURING THE EVALUATION STUDY PERIOD

Sources of Data	Data Collected
IDCTT Trainer	1. Student IDCTT Trainer Survey 2. Scenario Topics Survey (for IDCTT) 3. Source-of-Workload Evaluation 4. User Interface Dimensions Questionnaire 5. Student Grade Sheet
DC Central Trainer	1. Scenario Topics Survey (for DC Central Trainer) 2. Student Grade Sheet
Both Trainers	1. Student IDCTT vs DC Central Trainer Comparison Survey
Student Participation	1. Instructor IDCTT Survey 2. Instructor Interviews

1. Student Assignments

Students were in their final week of damage control school when they participated in the validation study. Three class days were scheduled for each of the data collection periods. During each of these periods, students were randomly assigned in groups of two for the IDCTT Trainer, and groups of five to seven for the DC Central Trainer. For each of the test periods, a class of 30 students were scheduled to participate in the study. However, due to scheduling conflicts and time limitations, only a portion of each group completed the entire evolution. The following guidelines were used to schedule the students through the two training methods:

- Half of the students were assigned to the IDCTT Trainer first while the other half used the DC Central Trainer. This procedure ensured each trainer had the same number of students exposed to its style first.
- Each of the two students assigned to the IDCTT Trainer was given one practice session and one graded session. Furthermore, The two students in the group exchanged duties as DCA and Plotter for a total

of two practice sessions followed by two graded sessions in one training period.

- The following four position sequences were randomly assigned to students performing in the IDCTT Trainer:
  1. *DCA-Plotter-DCA-Plotter,*
  2. *Plotter-DCA-Plotter-DCA,*
  3. *Plotter-DCA-DCA-Plotter,* and
  4. *DCA-Plotter-Plotter-DCA.*

- The student DCA for the DC Central Trainer was randomly selected from the group of five to seven students for each training group.

- Student groups were scheduled for 90 minute training periods for each training method.

2. Survey Administration

Before a survey was distributed, its instructions were read aloud, and students were encouraged to:

- Seek clarification on parts of the survey they did not understand, and

- Comment on items they felt were important, but were not included in the survey.

The order in which students received the six different surveys depended on which training method they were exposed to first. Surveys were distributed according to the guidelines shown in Table 3. Each survey was given to the students immediately after a training session (IDCTT Trainer, DC Central Trainer, or Both). Both the survey coordinator and instructors were available to clarify any misunderstandings the students had on the surveys. Instructor surveys were distributed after students completed their training sessions.

3. Student Scoring Criteria

Student performance was monitored and graded in both the IDCTT and DC Central Trainers. Grades were assigned based on students' demonstrated level of proficiency during the 90 minute training period. Grade assignments were standardized using the *Student Grade Sheet* criteria described earlier. This grading procedure provided student data for one

graded IDCTT Trainer session and one graded DC Central Trainer session.[24] It should be noted, however, that although the same grading criteria were used for both trainers, the ability of the instructor to monitor the students' performance varied between trainers. The following sections describe how instructors graded the students for each trainer type.

a. IDCTT Trainer Grading Protocol

Each of the two students assigned to the IDCTT Trainer completed one practice session as the DCA and one as the Plotter. Students were encouraged to ask questions about any aspect of the trainer they did not fully understand. After their questions were answered, and they reported feeling comfortable using the new trainer, each student completed one IDCTT Trainer scenario as the DCA and was assigned a quantitative grade that reflected their level of proficiency. Instructors observed the students' progression through the scenario from inside the IDCTT Trainer module room. This enabled instructors to visually monitor student input into the IDCTT's Command Console, and to observe the students' reactions to the various stressful situations. From this vantage point, instructors assigned grades on a scale from one to 100, based on the criteria specified on the *Student Grade Sheet*. Points were deducted depending on the percentage of each grading topic not completed.[25]

b. DC Central Trainer Grading Protocol

All students who participated in the evaluation received training throughout the DCA School's curriculum in DC Central Trainer operations. Thus, students were assumed to be proficient in this particular trainer before the day of the actual test session. Student

[24] Before the validation test date, students had completed seven different DC Central Trainer scenarios which were required for graduation from the DCA School. Thus, students were already skilled in the use of this method.

[25] It should be noted that although the IDCTT Trainer has a playback feature for post scenario debriefs, this feature was not used due to time constraints in student scheduling.

groups were scheduled for 90 minutes of DC Central Trainer simulation training using the Total Ship Survivability based battle problem. Students in this group were randomly assigned to the DCA and other positions by the instructor. The simulation was run once, and took the entire 90 minute training period to complete. As with the IDCTT Trainer, instructors graded student's performance based on the standardized grading criteria.

One aspect of the DC Central Trainer that deserves comment; that is, in this trainer, *the instructor is physically isolated from the students during the exercise*. Since only one instructor was assigned to each group, there was no direct means to evaluate the students' performance except from the inputs the instructor received from the other side of the wall. Unlike the IDCTT Trainer which recorded the entire training session and was designed to accommodate an instructor in the room, an error in the DC Central Trainer was lost if it was undetected in the voice communications. Generally, this arrangement would bias test results toward better performance in the DC Central Trainer because some mistakes would go unobserved causing higher performance scores.

4. Data Collection Pilot Test Period

Initially, the data were scheduled to be collected during 24 through 29 March 1994. This test period was the first time IDCTT was used outside the development facility. This pilot test period was used to test the system hardware and software performance in its intended operating environment, and to verify and standardize the data collection methodology.

a. Schedule

As discussed above, the validation series lasted three days, during which 30 students were scheduled to participate in the study. All 30 students completed the DC Central Trainer portion of the test sequence,

but due to frequent "crashes" of the IDCTT Trainer, only 12 students completed the IDCTT evaluation phase.[26]

The original test plan required each student to complete two practice sessions in the IDCTT Trainer followed by a third session which was graded. This procedure took about 90 minutes of single user IDCTT Trainer time per student; approximately the same amount of time as one DC Central Trainer scenario. Due to the limited time students were available for testing, this requirement was revised to one practice session followed by a graded session. Further, original test design required the student to operate the IDCTT Trainer in the single user mode, acting as their own plotter by manipulating the ISMS. This procedure was changed because students spent excessive time trying to find information using the ISMS, which distracted their attention from the main battle problem. To offset this attentional diversion, a second student was added to operate the ISMS and perform plotting duties.

The 30 student participants completed their scheduled IDCTT practice runs, but unexpectedly, this took the entire allocated testing period. The school was unable to accommodate the allocation of further testing time for the purpose of this pilot study due to its existing class schedules. The school permitted continued testing for the graded sessions, after hours, on a voluntary basis. Twelve of the 30 students volunteered to participate in this follow-on testing.

b. ISMS Removed

For the graded sessions, ISMS was dropped from the IDCTT Trainer system and replaced with DC Plates. ISMS was deleted for three reasons:

- Students had not been previously exposed to the ISMS system, thus requiring them to learn the two systems simultaneously.

[26] During the pilot test period, a system "crash" occurred approximately one time in every six training sessions. Once a "crash" occurred, the system had to be soft booted to reinitialize the training program. This procedure lost the previous scenario, thus requiring the student to start from the beginning.

- Students could not locate specific valve numbers from the piping diagrams due to the small scale representation.
- Software interface problems between the 486 computer and the ISMS system frequently caused the system to lock-up.

The ISMS system therefore was deleted from the IDCTT Trainer throughout the remainder of the validation study.

c. ***IDCTT Trainer System Improvements***

Upon completing the pilot test period, the IDCTT Trainer was [illegible] to CIM for software updates based on the information obtained during the pilot tests. These updates will be discussed later, but suffice it to say here that the revised version eliminated system crashes and improved the user interface and increased the likelihood that students would complete the scenario.

d. ***Summary***

From the information obtained during the pilot test period, the data collection methodology actually used was only slightly modified. Further, the prototype IDCTT Trainer was also modified based on information collected during the initial tests. After these changes were implemented, the IDCTT Trainer version was not modified during the remainder of the study.

D. DATA ANALYSIS METHODS

Upon completion of each test trial, all data were sorted and placed into individual student data packages. A student file contained the four data records:

- Short essay and narrative descriptions,
- Subjective Rating Data,
- Frequency data,[27] and
- Performance grades

[27] Frequency data were collected on the percentage of students who felt various features of the IDCTT Trainer required improvements.

These data were then compiled to accommodate the statistical analyses employed by this study. These statistical methods are described in the following sections.

1. Short Essay and Narrative Descriptions

Short essay and narrative descriptions were included in the validation study to augment the rating data and frequency responses. Because of the qualitative nature of the narratives, summary statistics could not be computed, but similar student responses were categorized, then summarized and listed for each subject. These listings provided a means, although subjective, to isolate patterns in student responses that further explicated their quantitative responses.

2. Rating Data

The rating data were analyzed using the Method of Equal-Appearing Intervals (MEAIS) (Thurstone and Chave, 1929). Using this method, the scale data obtained from the student questionnaires were compiled and placed in summary tables similar to that shown in Table 4.

TABLE 4: EXAMPLE MEAIS DATA MATRIX

Statement		Sorting Categories										
		1	2	3	4	5	6	7	8	9	10	11
	f	4	4	5	7	4	3	2	1	2	0	0
1.	p	.13	.13	.16	.22	.13	.09	.06	.03	.06	.00	.00
	cp	.13	.26	.41	.63	.75	.84	.91	.94	1.0	1.0	1.00

For each statement, three rows were used to display summary statistics from the student data. The first row (f), indicated the total frequency that students circled each number. The second row (p), displayed the frequency as a proportion to the total number of students. The final row (cp), cumulatively summed the proportion of frequency that had occurred through the numeric values.

> If the median of the distribution of judgments for each statement is taken as the scale value of the statement, then the scale values can be found from the data arranged in the manner of Table 4 by means of the following formula:

$$S=L+(.50-\sum p_b)\div p_w)\,i,$$

where S = the median or scale value of the statement
L = the lower limit of the interval in which the median falls
$\sum p_b$ = the sum of the proportions below the interval in which the median falls
p_w = the proportion within the interval in which the median falls
i = the width of the interval and is assumed to be equal to 1.0 (Edwards, p87, 1957).

The interquartile range provided a measure of the variability in the distribution of student responses. The interquartile range (Q or IQR) provided a numeric value representing the range of numbers in which the middle 50 percent of the scale judgments fell. To find Q, the 25th and 75th percentiles were calculated and subtracted using the following formulas:

$$C_{25}=L+(.25-\sum p_b)\div p_w)\,i,$$

where C_{25} = the 25th percentile of the statement
L = the lower limit of the interval in which the 25th percentile falls
$\sum p_b$ = the sum of the proportions below the interval in which the 25th percentile falls
p_w = the proportion within the interval in which the 25th percentile falls
i = the width of the interval and is assumed to be equal to 1.0 (Edwards, p89, 1957);

$$C_{75}=L+(.75-\sum p_b)\div p_w)\,i,$$

where C_{75} = the 75th percentile of the statement
L = the lower limit of the interval in which the 75th percentile falls
$\sum p_b$ = the sum of the proportions below the interval in which the 75th percentile falls
p_w = the proportion within the interval in which the 75th percentile falls
i = the width of the interval and is assumed to be equal to 1.0 (Edwards, p89, 1957);

$$Q=C_{75}-C_{25}.$$

Once the scale value (S) and the interquartile range (Q) were calculated for each statement, summary statistics indicating students reaction to the various items were compiled for further analysis.

3. Frequency Data

Frequency data were analyzed using the proportion of students who responded to each check-list item. This summary statistic was obtained by summing the number of students who checked each item and dividing by the total number of students in the study. This information provided a percentage of students who agreed on each checklist item.

4. Performance Grades

The significance of the differences between paired performance grades for the IDCTT and DC Central Trainer was evaluated using the Large-Sample Wilcoxon Signed-Rank Test for a Paired Experiment (Mendenhall, 1990). This test determines if the relative frequency distribution for the two sets of grades are identical or different.

The following summarizes the testing procedure.

> To carry out the Wilcoxon test, the Differences for each of the paired scores is calculated. Differences equal to zero are eliminated. The rank of the absolute values for each of the numbers is determined, assigning a 1 to the smallest, 2 to the second smallest and so on. The rank sum is calculated for each the positive and negative differences. The positive value of these two calculations is used to calculate the z value from the normal curve and is used as the test statistic the test statistic.[28] This test statistic is then compared against the z value for the appropriate significance level desired. This comparison is used to determine if the null hypothesis, that the two frequency distributions are the same, should be accepted (Mendenhall, p.680, 1990).

The results of this test provided a means for evaluating whether the trainers were equally effective as a student training aid.

E. SUMMARY

The pilot test period indicated that the validation test plan was practicable, with only slight modifications. As a result of the pilot test, the prototype trainer underwent only minor software updating, and

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[28] See Appendix C for the z value equation.

the ISMS system was dropped from the IDCTT Trainer. Accordingly, a summary of the validation methodology is displayed in Figure 1 for the convenience of the reader.

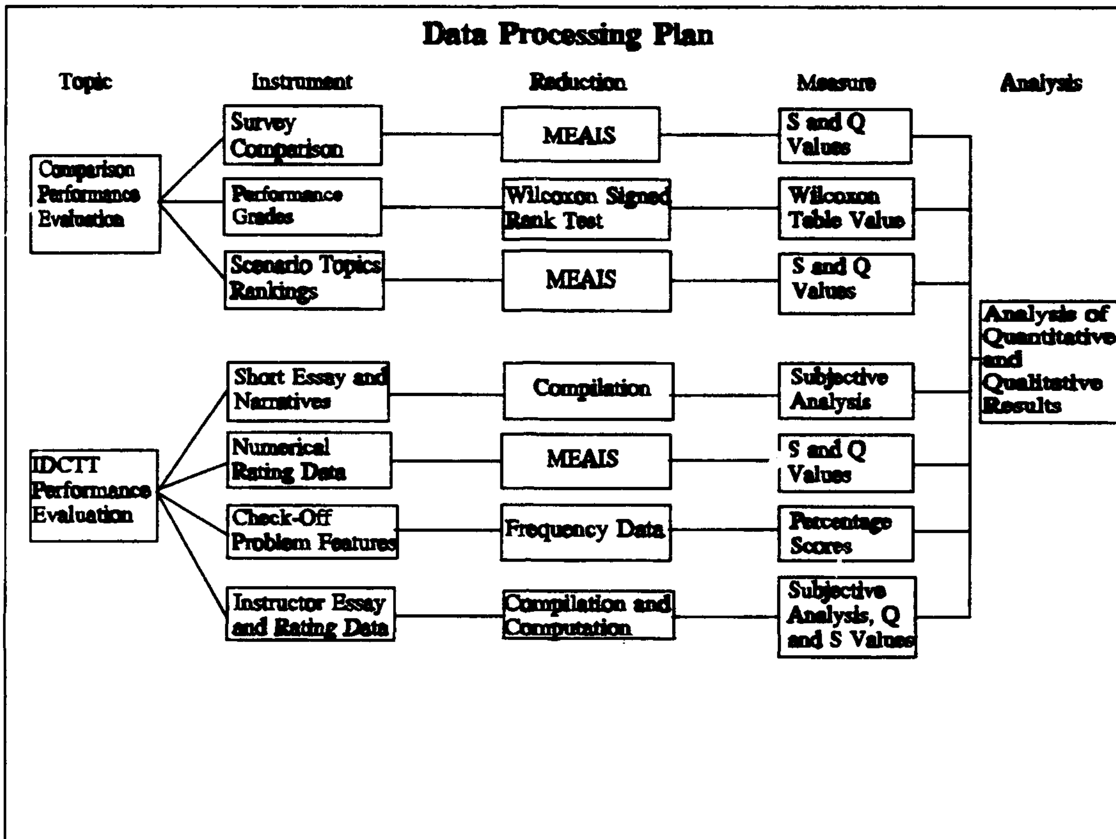

Figure 1: Data Processing Plan

III. RESULTS

This chapter presents the results obtained from the validation effort's experimental group. The validation experimental group consisted of 32 students from two separate classes. As previously stated, data were collected on a total of 32 students; 22 students who were tested between 19 and 21 April 1994, and 10 students who were tested between 20 and 22 June 1994. Students in this test group represented a cross section of the average classes' fleet experience level, and damage control aptitude (Jullian, 1994).

The data are presented in two sections. The first section presents the results of the IDCTT Trainer performance evaluation; that is, the evaluation of the IDCTT Trainer alone. The second section provides the results of the IDCTT versus DC Central Trainer performance comparison. No attempt is made to provide a substantial discussion of the results in this chapter. That will take place in the next chapter.

A. IDCTT TRAINER PERFORMANCE EVALUATION

Again, data were collected from 32 students undergoing instruction and the eight Damage Control School instructors to evaluate the IDCTT Trainer. These data were comprised of short essay and narrative descriptions, rating data, check-off problem features, and instructor evaluations. These results are presented in the following four sections.

1. Short Essay and Narrative Descriptions

Short essay and narrative descriptions were solicited from students using the *Student IDCTT Trainer Survey*. Each student responded to five essay questions. The first question which asked students to identify and explain any IDCTT Trainer feature which caused them difficulties while interacting in the IDCTT training environment, are summarized in Table 5. The final four questions, which also dealt with

IDCTT features, are similarly summarized in Table 6.[29] A compilation of all the students' responses is included in Appendix B

TABLE 5: STUDENT RESPONSES TO A LIST OF IDCTT TRAINER FEATURES IN WHICH THEY WERE ASKED TO EXPLAIN WHICH FEATURES CAUSED THEM DIFFICULTY WHILE OPERATING THE SYSTEM

Feature	**Comments**
Touchscreen Monitor	1. Touchscreen is not sensitive to the touch and responds slowly to student inputs. 2. The screen displayed options which can not be activated or serve no purpose. 3. Option selections buttons are too close together causing accidental inputs into the IDCTT Trainer. 4. Students were unfamiliar with which option selection was necessary to initiate specific actions.
Understanding Audio Reports	1. Background audio track contained clearly erroneous information. 2. Unable to ask computer simulated watchstanders to repeat previously given information.
Finding DC Plate Information	1. Student unfamiliarity with the design of the DDG-51 Class Destroyer made locating information from it's DC plates difficult. 2. Lack of practice in using DC Plates made it difficult to find information from the DC Plates within the limited time allotted in the quick pace of the IDCTT scenario.
Speed or volume of information presented	1. The scenario was too fast for beginners, the scenario pace should be adjustable to meet the student's level of expertise.
DC Alarm Panel Display	**No Responses**
Firemain Panel and firemain valve and pump operations	1. The firemain Alarm Panel Screen was too small making it difficult to read valve numbers and labels.
Other features not listed	1. Unfamiliarity with the system made it initially difficult to operate. 2. System is unresponsive to student inputs to activate all relevant valves or investigate and combat damage in some of the damaged compartments. 3. Unable to obtain specific information on integrity of the chill water system.

[29] Summary statements are based on a compilation of written and oral responses selected as a representation of the students' responses. A complete listing of all student responses is included in Appendix B.

TABLE 6: SUMMARY OF STUDENTS' SHORT ESSAY AND NARRATIVE RESPONSES TO STUDENT IDCTT TRAINER SURVEY NARRATIVE QUESTIONS

Question	**Comments**
How can the touchscreen control panel be improved?	1. Increase the size of the number pad on the touchscreen or only use the computer keyboard. 2. Increase the touchscreen sensitivity. 3. Use a mouse to select options or switch to voice activation technology. 4. Eliminate the touchscreen options which are not activated.
What problems did you encounter while using the IDCTT Trainer?	1. Inputing information in the Command Console touchscreen monitor. 2. Unfamiliarity with the DDG-51 Class Destroyer made it difficult to visualize what the information received meant. 3. Not fully understanding what each button option would do stemming from inexperience in using the system. 4. Inexperience in making reports to the Commanding Officer, while the system provided no clear means to report to him. 5. Little or no knowledge of the chill water system. 6. System occasionally locked-up for no apparent reason.
What aspects of the IDCTT Trainer did you like the most?	1. The trainer was extremely realistic. 2. The amount of stress induced by the system. 3. Ability for one person to train without the need for an entire watch team. 4. Clarity of information the IDCTT Trainer presented. 5. Fast pace and audio-visual presentation of the information. 6. Printed damage control chits. 7. Enables the user to observe the consequences of their actions while providing the option to repeat the scenario until it is done correctly.
What aspects of the IDCTT Trainer did you like the least	1. Only one scenario for only one ship class. 2. Difficulties experienced while inputing information into the touchscreen monitor. 3. The emphasis on the chill water system when the student users were not trained in this area. 4. Reasons for "kill point" activation were too vague.

2. Subjective Rating Data

Subjective rating data were collected using the *Student IDCTT Trainer Survey*, *Source-of-Workload Evaluation*, and *User Interface Dimensions Questionnaire*. Each survey measure solicited different aspects of the trainer by responses on a scale from 1 to 11. The scale values and

interquartile ranges (IQR) for these surveys are presented in Tables 7, 8, and 9.

TABLE 7: SCALE VALUES AND INTERQUARTILE RANGES OF ITEMS EVALUATING STUDENT IMPRESSIONS OF NINE DESIGN ASPECTS OF THE IDCTT TRAINER

Question	Scale Value	IQR
How easy was the system to operate? (Difficult..Easy)	8.72	1.47
Relevant information options on touchscreen monitor? (None..All)	7.09	3.00
How easily touchscreen allowed information input? (Difficult..Easy)	7.91	4.55
Was the scenario too difficult? (Difficult..Easy)	4.39	1.72
Was the scenario easy to understand? (Confusing..Clear)	8.14	2.27
Was the scenario's pace too slow? (Fast..Slow)	5.61	1.34
Was the scenario realistic? (Unrealistic..Realistic)	8.21	1.87
Usefulness as a DC School Training aid? (Worthless..Useful)	9.61	1.23
Usefulness as a shipboard training aid? (Worthless..Useful)	9.61	1.55

TABLE 8: SCALE VALUES AND INTERQUARTILE RANGES OF ITEMS EVALUATING STUDENTS IMPRESSION OF EIGHT INTERACTIVE COURSEWARE INTERFACE DIMENSIONS

Statement	Scale Value	IQR
Ease of use (Difficult..Easy)	8.32	2.03
Navigation through ICW (Difficult..Easy)	8.39	2.03
Cognitive load (Unmanageable..Manageable)	8.74	1.74
Mapping (None..Powerful)	8.89	1.45
Knowledge of space compatibility (Incompatible..Compatible)	8.93	1.88
Information presentation (Obtuse..Clear)	9.92	1.43
Media Integration (Uncoordinated..Coordinated)	9.77	1.94
Overall Functionality (Dysfunctional..Highly Functional)	9.64	1.98

TABLE 9: SCALE VALUES AND INTERQUARTILE RANGES OF ITEMS EVALUATING STUDENT IMPRESSIONS OF SIX HUMAN WORKLOAD DEMAND DIMENSIONS

Dimension	**Scale Value**	**IQR**
Mental Demand (Low..High)	9.76	1.84
Physical Demand (Low..High)	3.50	3.77
Temporal Demand (Low..High)	9.21	1.90
Performance Demand (Low..High)	8.86	2.36
Effort Demand (Low..High)	9.50	1.79
Frustration (Low..High)	6.50	4.75

3. Check-Off Problem Features

Students were presented with seven IDCTT Trainer features and asked to indicate which features, if any, caused them problems. The number of student responses and the percentage of students who identified each topic as an area where improvements should be made are provided in Table 10.

TABLE 10: NUMBER AND PERCENTAGE OF STUDENTS WHO IDENTIFIED CHECK-OFF SHEET ITEMS AS FEATURES OF THE IDCTT TRAINER WHICH COULD BE IMPROVED

IDCTT Trainer Feature	**Number of Students Who Checked Each Feature out of 32 Students**	**Percentage of the 32 Students Who Checked Each Feature**
Operating touchscreen monitor	19	59
Understanding audio reports	2	06
Locating DC Plate information	7	21
Speed/Volume of information	12	38
DC alarm panel display	0	00
Firemain panel and pump operations	6	19
Other features not listed	5	16

4. Instructor Evaluations

Short essay and narrative descriptions, as well as rating data were collected from the Damage Control School instructors using the *IDCTT*

Instructor Survey. A summary of the instructor comments answers is provided in Table 11. Table 12 provides the results from the instructor rating responses and interquartile ranges from the five rating categories solicited. Appendix B contains a complete listing of all the instructors' short essay and narrative descriptions.

TABLE 11: SUMMARY OF INSTRUCTOR SHORT ESSAY AND NARRATIVE RESPONSES TO QUESTIONS FROM THE INSTRUCTOR IDCTT TRAINER SURVEY ON THE OPERATION OF THE IDCTT TRAINER

Question	**Comments**
What aspects did you like about the IDCTT Trainer for teaching damage control problems?	1. Ability of the IDCTT Trainer to present identical scenarios to each DCA student. 2. The level of realism that the IDCTT Trainer induces. 3. Ability to objectively critique the DCA's actions. 4. Reinforces basic and advanced damage control concepts.
What problems did you encounter while using the IDCTT Trainer as an instructional aid?	1. The program did not run real time, rather it moved more like a video game. 2. Touchscreen monitor slowed student responses. 3. Student unfamiliarity with the system. 4. Extensive pre-brief in classroom required to fully prepare students for IDCTT.
What aspects of the IDCTT Trainer would you like changed?	1. Provide more detailed feedback from the repair lockers in response to incorrect or improper orders. 2. Change the method of inputing orders from the touchscreen to voice recognition. 3. CSMC should have its own repair team to isolate and correct chill water problems. 4. Increase the number of scenarios.
What benefits do you envision from the use of the IDCTT Trainer at the Damage Control School?	1. May be used as a final simulation to objectively determine a students' ability to operate under stressful conditions. 2. Better preparing DCA students for the pressures and problems associated with actual damage control scenarios in the fleet.

TABLE 12: SCALE VALUES AND INTERQUARTILE RANGES OF ITEMS EVALUATING INSTRUCTORS IMPRESSION OF FIVE ASPECTS OF THE IDCTT TRAINER

Question	Scale Value	IQR
How easily did IDCTT allow you to instruct students? (Difficult..Easy)	6.50	3.00
How realistic was the IDCTT Trainer? (Artificial..Realistic)	5.50	3.50
Extent you would like to see IDCTT installed permanently at the DCA School? (Very Little..Very Much)	6.50	2.00
Rate the students reaction to the IDCTT Trainer? (Negative..Positive)	7.50	1.50
How beneficial would IDCTT be as a shipboard trainer? (Detrimental..Beneficial)	5.00	1.50

B. IDCTT VERSUS DC CENTRAL TRAINER PERFORMANCE COMPARISON

The same 32 students were used in the IDCTT versus DC Central Trainer performance comparison as those in the IDCTT Trainer performance evaluation. The data consisted of graded student performance and rating data. The results are presented below.

1. Graded Student Runs

Each of the 32 student participants received two grades, one for their performance in the IDCTT Trainer and the other for the DC Central Trainer. These scores provided paired scoring data which was analyzed using the Wilcoxon Signed Rank Test. The Wilcoxon Signed Rank Test revealed that the population relative frequency distribution of the IDCTT Trainer performance scores was shifted to the right of the DC Central trainer performance scores ($.025 \leq P \leq .01$). Table 13 compares summary statistics for the two sets of students' scores, while Appendix C contains the raw data scores and the Wilcoxon Signed Rank Test results.

TABLE 13: SUMMARY STATISTICS FOR STUDENT SCORES RECEIVED DURING THE PERFORMANCE EVALUATION SESSIONS FOR THE IDCTT TRAINER AND THE DC CENTRAL TRAINER

Statistical Parameter	**IDCTT Trainer Parameter**	**DC Central Trainer Parameter**
Mean	89.34	86.53
Median	91.5	86.5
Standar_ Deviation	6.24	5.01
Skewness	-0.85	-0.06
Minimum Score Achieved	72	79
Maximum Score Achieved	99	93

2. Rating Data

Scale values and interquartile ranges were compiled from data collected by the *Student IDCTT vs DC Central Trainer Comparison Survey* and the *Scenario Topics Ranking Survey*. Table 14 compares the scale values and interquartile ranges. Scale values span an 11 point bipolar scale: low scores indicate a preference for the IDCTT Trainer; high scores indicate a preference for the DC Central Trainer. a six is neutral.

Table 15 shows the scale values, interquartile ranges and rank order for each fundamental damage control topic. These data were obtained by the IDCTT and DC Central Trainers' *Scenario Topics Ranking Survey*. It should be noted that unlike previous survey scales used in the present study which employed an eleven point range, <u>the *Scenario Topics Ranking Survey*, students' responded on a seven point scale</u>. The higher the scale value for a topic the more important the topic was in successfully completing the scenario problem.

TABLE 14: SCALE VALUES AND INTERQUARTILE RANGES OF ITEMS COMPARING STUDENTS IMPRESSIONS OF THE IDCTT TRAINER AGAINST THE DC CENTRAL TRAINER COMPARISON ACROSS 11 OPERATIONAL AND DESIGN CHARACTERISTICS

Question	Scale Value	IQR
Simulated the shipboard environment more realistically	4.04	2.73
Enabled instructors to provide complete post scenario debriefs	4.06	3.36
Produced the greatest level of stress	2.50	3.26
Allowed instructors to monitor student's performance	2.71	2.50
Prepared the student for actual shipboard emergencies	4.06	4.29
Updated student inputs more easily	3.83	6.00
Provided scenario information closely resembling shipboard methods	4.50	4.50
Provided most effective teaching environment to exercise damage control skills	3.50	3.67
Promoted greater learning in time allotted	2.38	2.47
Preferred training method	1.39	2.89
Stimulated the student to perform	2.86	2.75

TABLE 15: SCALE VALUES, INTERQUARTILE RANGES AND RANK ORDERS COMPARING THE IMPORTANCE OF FUNDAMENTAL DAMAGE CONTROL TOPICS IN COMPLETING THE IDCTT AND DC CENTRAL TRAINERS' SCENARIO BATTLE PROBLEM

Measure	**Scale Value**		**IQR**		**Rank**	
	IDCTT	DC Central	IDCTT	DC Central	IDCTT	DC Central
Communications	4.06	6.11	3.00	1.56	11	3
Inform chain of command	4.19	5.33	2.37	1.46	10	9
Set Zebra	5.85	5.21	1.92	1.80	6	10
Restore Vital Systems	6.78	6.32	0.85	1.34	1	1
Manage DC Central	4.96	5.34	3.62	2.37	9	8
Isolate damage	6.61	6.07	1.04	1.27	2	4
Manned and Ready	3.97	4.17	3.24	2.64	12	12
Restore Firemain	6.08	5.89	1.42	1.45	3	6
Manage Personnel casualties	1.98	2.69	1.96	2.59	13	13
Locate damage	5.60	5.60	1.69	1.61	8	7
Prioritize damage	5.61	5.18	3.50	2.84	7	11
Coordinate fire fighting teams	5.98	6.17	1.91	1.32	4	2
Isolate explosive hazards	5.98	6.06	2.62	1.05	5	5

IV. DATA ANALYSIS AND DISCUSSION

Data collected from the validation test group allowed two circumscribed analyses: an analysis of the IDCTT Trainer performance alone and a comparative analysis of the IDCTT versus the DC Central Trainer. This chapter analyzes the results for these two evaluations. The first part addresses the IDCTT Trainer performance evaluation and reports the findings from the short essay, rating data, check-off problem features, and instructor evaluations. The second part contrasts the IDCTT Trainer's performance with the DC Central trainer, using the rating data and short essay responses reported in the last chapter.

A. IDCTT TRAINER PERFORMANCE EVALUATION

The IDCTT Trainer performance evaluation's objective was to collect sufficient data to determine the effectiveness of the IDCTT Trainer as a student training aid and an instructor teaching tool. The focus of the present treatment is four-fold. First, to determine if users easily interacted within the IDCTT environment and to examine features of the IDCTT Trainer which might be improved. Second, the scenario itself was examined to determine its effectiveness as a simulated battle training problem. Third, the actual student workload using the IDCTT Trainer was evaluated to determine if the trainer provided an acceptable training environment. Finally, the instructors' evaluation of the IDCTT Trainer was examined to establish a basis in experienced opinion regarding the system's usefulness as a training tool. These four themes are presented in the following four sections:

- System User Interface,
- Scenario Critique,
- Student Workload, and
- Instructor Evaluation.

1. System User Interface

The *Student IDCTT Trainer Survey* and the *User Interface Dimensions Survey*, were used to determine students' reaction to the IDCTT Trainer's hardware and software features. These surveys provided short essay information, rating data, and check-off problem features as discussed in Chapter Two. The results are discussed below.

a. Student IDCTT Trainer Survey Analysis

Scale values calculated from the Student IDCTT Trainer Survey indicated that ***students liked the IDCTT Trainer package and felt it was an extremely useful training aid*** (see Figure 2). Students generally agreed (IQR = 1.47) that the ***system was easy to operate*** (S = 8.72). Moreover, respondents indicated a slightly stronger than neutral attitude that the information options presented by the Command and Control Console were adequate to successfully combat the scenario (S = 7.09); however, their responses to this question tended to vary more widely (IQR = 3.00). Interestingly, the survey revealed that students generally accepted the touchscreen monitor as an easy method for inputing data into the system (*S* = 7.91), despite comments in the essays and features check-off section which identified the touchscreen monitor as an area where improvements should be made.[30] Students' responses on items concerning the touchscreen monitor's performance revealed a substantial lack of consensus (IQR of 4.55).

The trainer's ratings of usefulness as a DC School training aid or as a potential shipboard training aid, were very high and consistent across students. The usefulness ratings were 9.61 in each case, with very low IQRs of 1.23 and 1.55 respectively.

b. Operating System

Students were clearly favorably impressed with the system's operational characteristics. Despite the high positive scale values

[30] These findings will be discussed later.

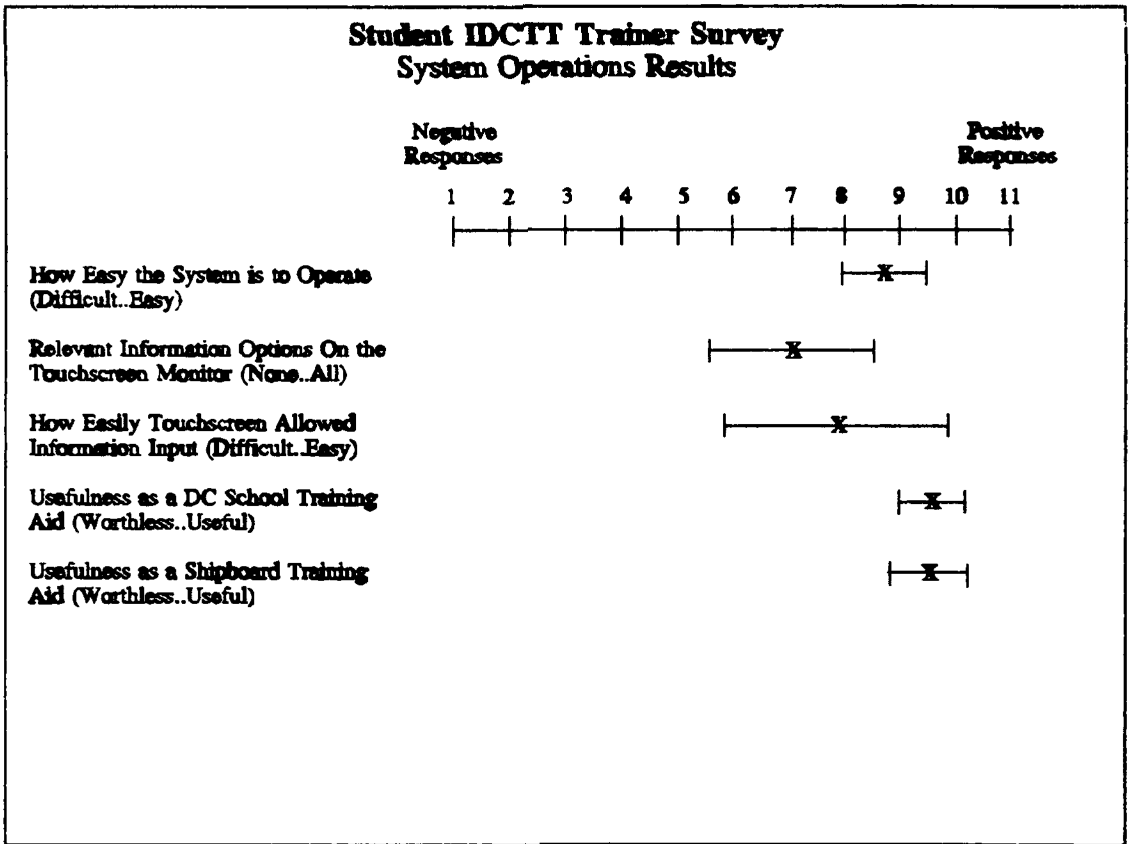

Figure 2: Scale Values and Interquartile Ranges of Items Evaluating Student Impressions of Five Design Aspects of the IDCTT Trainer

associated with the touchscreen monitor's operational characteristics, most of the problems identified with the system were rooted in using the touchscreen monitor to input information into the system. The *Check-Off Problem Features List* was administered to identify areas in the IDCTT Trainer which needed improvement. Figure 3, graphically displays the percentage of students who identified each of the seven IDCTT Trainer features as areas where they encountered difficulties.[31] The following discusses these findings as they relate to seven specific features:

- Operating the touchscreen monitor,
- Understanding audio reports,
- Locating DC Plate information,

[31] The seventh IDCTT Trainer feature was an "other" category, enabling students to identify problem areas not listed.

- Speed or volume of information presented,
- DC Alarm Panel display,
- Firemain Panel and firepump operations, and
- Other features not listed.

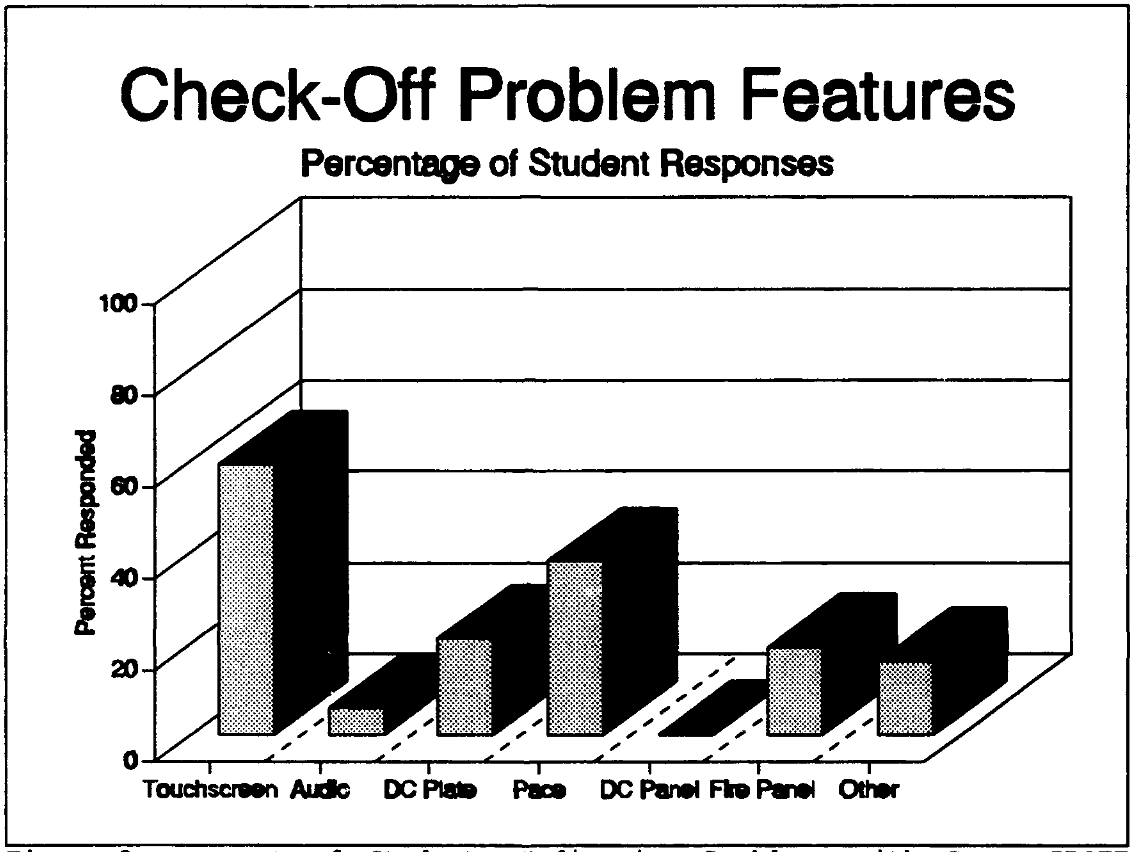

Figure 3: percent of Students Indicating Problems with Seven IDCTT Trainer Features

(1) Touchscreen Monitor. ***Fifty-nine percent of the students indicated they experienced some difficulty operating the touchscreen monitor***. More specifically, they identified difficulties inputing information into the touchscreen as the cause for missing key audio reports, and in some cases, *losing control of the battle problem*. ***The touchscreen's primary problem was its low sensitivity to touch and its slow response time***. Students often selected the correct button, but the touchscreen did not sense their input. Further, the actual physical distance between the buttons was narrow, causing students to accidentally

choose the wrong option. This was particularly frustrating when inputing fire and flooding boundaries. Ordering boundaries required pressing a sequence of up to 14 buttons, taking upwards of 30 seconds of problem clock time to complete. ***An accidental input during this sequence could seriously affect the student's performance by causing them to focus their attention on repeating the 14 button process rather than the flow of information from the various sources.*** Most of the students opted to use the computer keyboard instead of the touchscreen's numeric key pad. However, switching back and forth between the computer keyboard and the touchscreen monitor was difficult because only numeric inputs and the enter command could be initiated from the computer keyboard.

Many of the students had never used a touchscreen monitor before this study, but they became markedly faster with practice. Still, comments in student essays revealed an underlying sentiment to either ***increase the sensitivity of the touchscreen or explore different methods for inputing information***. These suggestions included:

- Voice activation,
- Using a mouse,
- Making all action available on the computer keyboard, and
- Designating an individual to input all orders into the touchscreen.

(2) Volume of Information. The next most frequently reported problem concerned the *speed or volume of information presented.* ***Thirty-eight percent of the students indicated they had problems with the pace of information flow***, but student essay responses did not provide information as to why: only five students specifically addressed this area. Although some students seemed to be overwhelmed with the speed and volume of information during their practice run, ***most appeared to be comfortable with the pace by the time they reached their graded session.*** <u>*Some students specifically identified the fast pace as instrumental in making the trainer scenario seem more realistic*</u>. Interestingly, one student suggested programming different difficulty levels, such as

"beginner", "intermediate", and "advanced", thus enabling slower students to practice at levels more conducive to their stage of skill development.

(3) DC Plate, Firemain Alarm Panel and Pump Operations. Approximately the same percentage of respondents identified "locating DC Plate information" (21 percent), and the "Firemain Alarm Panel and pump operations" (19 percent), as problem areas during their evaluation trials. Students attributed their difficulties locating DC Plate information to their unfamiliarity with the DDG-51 class. Although this is not a shortcoming of the IDCTT Trainer, ***it indicates the need for more scenarios with different ship classes to support the diversity of fleet experience***. While the IDCTT Trainer was not designed to instruct students on reading DC Plates, its continued use will familiarize students with the DDG-51 class ship generally and reading their DC Plates specifically.

Respondents indicated ***the main problem with the Firemain Alarm Panel was the small display screen***. The Firemain Panel is displayed on a 15 inch color monitor. Since the display screen symbolically represents over thirty of the primary firemain valves and six firepumps, the size of the valves and pumps are small given the limited screen space. ***Students often overlooked critical indications on the Firemain Panel because they simply did not notice any changes in the compact display***. Two solutions to this problem are readily apparent.

- A larger Firemain Panel Screen would proportionally increase the size of each Firemain Panel feature without altering the present display, and
- Reducing the number of valves displayed to those critical to the scenario, thus allowing more room for those remaining.

Adopting a larger screen is preferred because it enables the students to actually see a representation of the DDG-51 class Firemain Panel.

(4) Audio Reports, DC Alarm Panel, and Features Not Listed. The areas which needed little or no improvements were, "other features not listed in the survey" (16 percent), audio reports (6 percent), and the DC alarm panel (no responses). *Unfamiliarity with the system*, particularly not knowing what actions the IDCTT Trainer did automatically and what

orders had to be manually inputed to accomplish specific tasks, summarize the responses for the features not listed in the survey. Students suggested using a demonstration tape to provide a step by step sequence through the various options.[32]

For audio reports, respondents indicated that they became distracted by erroneous information in the background noise. Background noise is simply a compilation of actual reports delivered to the DCA over the Command and Control Console. It is played continuously on a separate audio track. Unfortunately, many of these reports are erroneous,[33] depending on the student's previous corrective actions to combat the damage. This problem could be easily rectified by recording background information that is relevant, but general in nature. This would provide an appropriate distraction, but would not give the DCA mis-information.

No student in the study identified any problems with the DC Alarm Panel. Although the DC Alarm Panel was displayed on a 15 inch color monitor similar to the Firemain Alarm Panel, there were no problems reported with the size of the graphic representation of the various alarms.

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[32] Each student attended a 90 minute lecture on the background and functions of the IDCTT Trainer. This lecture used overhead transparencies of the IDCTT Trainer's screen displays rather than the actual system. Respondents felt the overhead transparencies did not sufficiently prepare the students for the actual trainer.
Although there is a demonstration option on the IDCTT Touchscreen, this option simply repeats a complete scenario, darkening the buttons that would be pressed for the various actions taking place on the screen. There is no audio voice over in the demo to explain the actions that are being taken. Further, watching the present demo tape prior to system use would predisclose the battle problem because it is the same scenario that the student would use.

[33] Erroneous reports include, "High Temperature Alarm in the VLS Magazine", "Loss of Firemain pressure", and "Complete loss of Chill Water, no radar arrays on line". Each of these reports potentially cause the student to take unnecessary corrective actions.

c. ***User Interface Dimensions***

The *User Interface Dimensions Survey* measured student responses across eight conventional interactive courseware dimensions. ***Student responses were clearly positive on each dimension***; the scale values ranged from 8.32 to 9.92. Further, there was little variation in the student responses; the IQR ranged from 1.43 to 2.03.[34] Figure 4 depicts these results graphically.

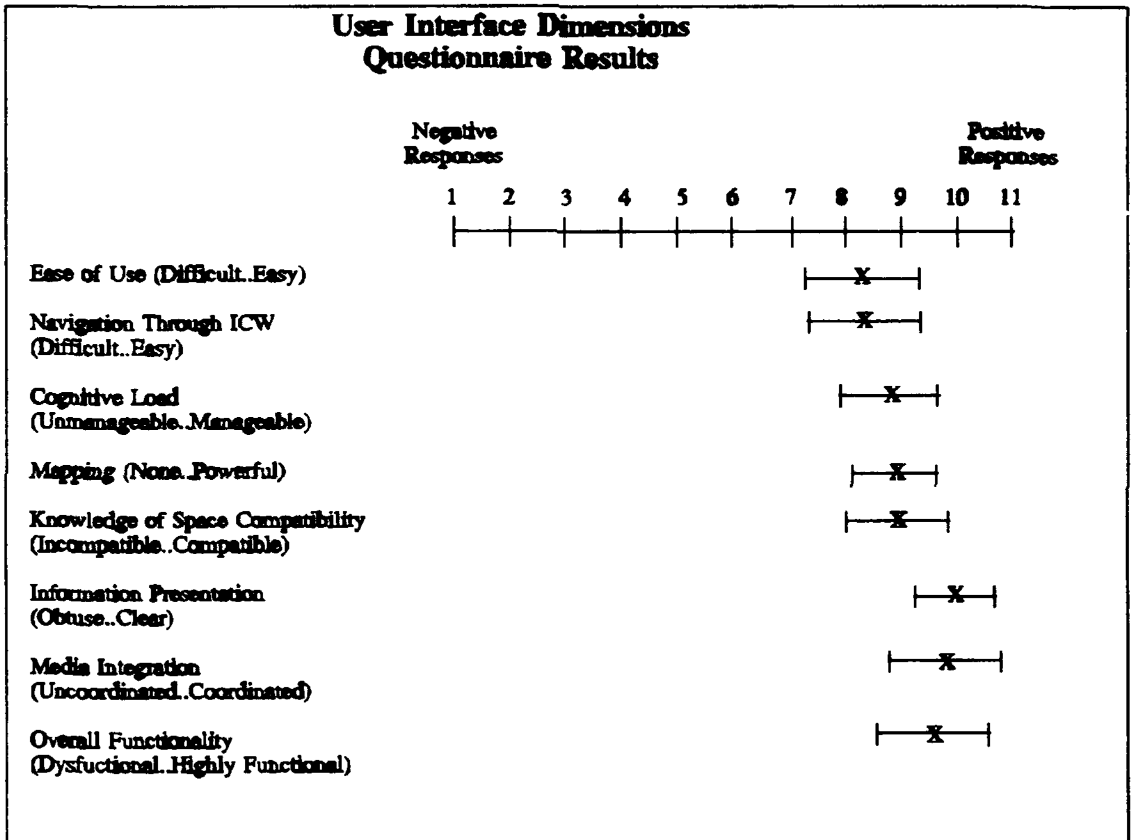

Figure 4: Scale Values and Interquartile Ranges of Items Evaluating Student Impressions on Eight ICW Interface Dimensions

2. Scenario Critique

Figure 5 reveals that student reactions to the IDCTT Trainer's scenario were highly positive. The validation group reported that the ***scenario was easy to understand*** (S = 8.14) and was ***extremely realistic*** (S

[34] See Table 6 for a complete summary of the scale values and interquartile ranges for each interface dimension.

= 8.21). Responses on both aspects of the scenario showed little variation as reflected in the narrow IQRs of 1.87 and 2.27, respectively. Students were neutral and in agreement on the pace of the scenario (S = 5.60; IQR of 1.34). Finally, the validation group agreed that the scenario was ***difficult to complete*** (S = 4.39; IQR = 1.72). The following four sections address various aspects of the scenario used and student reactions to it.

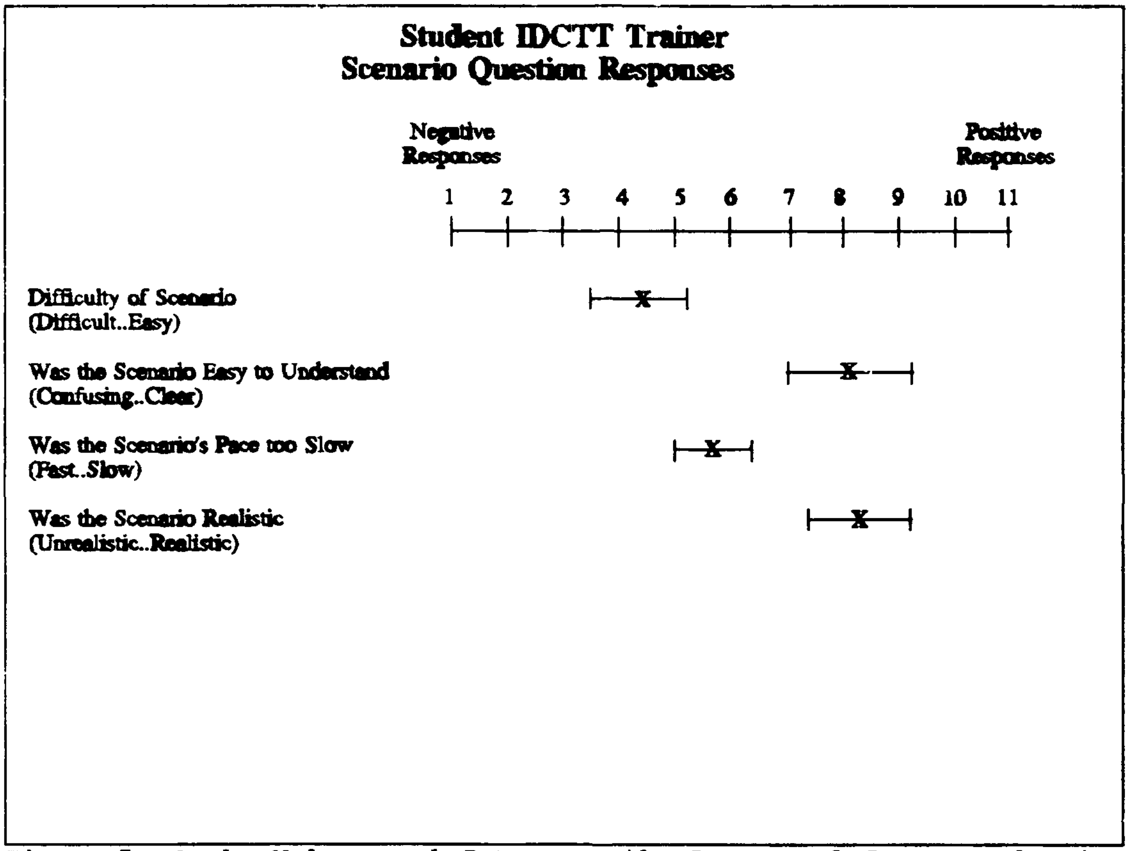

Figure 5: Scale Values and Interquartile Ranges of Items Evaluating Student Impressions of Four Scenario Design Aspects

a. Scenario Realism

Student narratives cited ***audio and visual effects as the main reasons why the trainer was so successful in creating what they considered a realistic training scenario***. Further, they revealed that the realism was heightened in that the printed damage control chits provided another information source they would receive if they were performing in an actual

shipboard battle damage situation. Moreover, they reported that the information flow closely tracked that which they would experience in an actual shipboard multi-hit scenario.

b. Scenario Clarity

Essay responses and narratives, clearly indicated that the ***scenario objectives were clearly defined***. Student responses repeatedly suggested that the progression of steps needed to complete the scenario tracked the standard procedures taught at the Damage Control School.[35] Two items, however, were identified as potential problems with understanding the IDCTT Trainer scenario. The first was an insufficient knowledge of the chill water system to make rational decisions on the corrective actions necessary to isolate and repair it. The second problem stemmed from an underlying unfamiliarity with the DDG-51 Class Destroyer which made it difficult for students to fully comprehend the information they received. These two topics are amplified.

(1) Chill Water. Some of the students identified ignorance of chill water system as the basis for their inability to successfully complete the scenario. Fourteen of the 32 students (44 percent) did not complete the scenario due to chill water related problems. The IDCTT Trainer scenario emphasized chill water system restoration as one of the primary actions needed to complete the problem, and did so to attain the central goal of incorporating TSS concepts into the battle problem. The chill water system, however, was not taught at the Damage Control School and students were left with the limited knowledge they obtained at previous schools or experienced in the fleet. ***The Damage Control School should review its course curriculum and place a stronger emphasis on the chill water system if the curriculum is to reflect the shift in fleet doctrine toward the TSS philosophy.***

[35] Successful completion of the scenario requires students to investigate damage, set boundaries, combat damage, and repair the damage. This broad sequence of events are the fundamental steps taught to damage control students in managing damage control situations.

(2) DDG-51 Class Unfamiliarity. Another scenario related problem was that the scenario was based on a class of ship with which most were unfamiliar. Since the DDG-51 Class is the newest ship class, most of the students were unfamiliar with its design, making it difficult to locate compartments and valve numbers from the DC Plates. Although the students were not familiar with the DDG-51 Class design, the concepts used to combat damage are the same, regardless of the ship's design, and students who employed solid damage control concepts were able to successfully complete the scenario, even if they did not know the ship class specifics. When scenarios are written for different ship classes, students will be able to choose their ship class from a library of scenarios, tailoring training to the knowledge they need to bring back to the fleet.

c. Scenario Pace

Students' reaction to the scenario pace was neutral. Although some students fell behind in the problem, they attributed the lag to the slow process of inputing information through the touchscreen rather than the flow of information itself. Most students felt that the fast flow of information added to the realism of the scenario and induced a level of stress that would be present under an actual damage control scenario.

d. Scenario Difficulty Level

Students felt the scenario was difficult and only one out of 32 students successfully completed the scenario during the practice session. This low completion was partially attributed to the students' unfamiliarity with the system's operating procedures during the practice run. However, the low completion rate underscores the difficulty of the scenario. The scenario was not designed to be easy, but to provide a challenging learning environment in which students could practice the damage control concepts they learned in the classroom. Further, it was designed to identify student mistakes so this knowledge could be applied

and those mistakes rectified in subsequent trainer sessions. Thus, ***the students' prevailing experiences that the scenario was difficult reflected the designers original intentions: the exercise was to be difficult.***

3. Student Workload

Student workload was evaluated using NASA's *Source of Workload Evaluation*. The IDCTT Trainer was developed to produce a learning environment that imposed significant mental, temporal, and attentional demands.[36] ***Respondents rated the system as mentally and temporally demanding*** while requiring a high lev[illegible]t to complete the IDCTT Trainer scenario. Scale values for these categories ranged from 9.21 to 9.76, with very narrow ranges (IQRs of 1.79 and 1.90, respectively). As one would expect from a computer based simulation, students rated the physical demand required by the system as low (S = 3.50). When asked to rate the level of frustration they encountered while interacting with the system, student responses were essentially neutral (S = 6.50), but reflected significantly more variation in that assessment (IQR = 4.75).

A review of students' performance grades indicated that those who performed poorly were more likely to be frustrated while using the system than those who performed well or vice versa. This finding explains the wide range of responses to the "level of frustration" survey question. Most students were satisfied with their personal performance level (S = 8.86; IQR = 2.36). Figure 6 graphically depicts the student responses for the various categories.

4. Instructor Evaluation

The instructors' evaluations of the IDCTT Trainer were generally neutral. Figure 7 shows the instructors' responses. Unfortunately, *only three of the seven instructors at the DCA school (43 percent) spent more than two hours operating the system and assisting students*. The remaining

[36] See the Subject Instructions and Survey for the *Sources of Workload Evaluation* contained in Appendix B for a complete description of each workload factor.

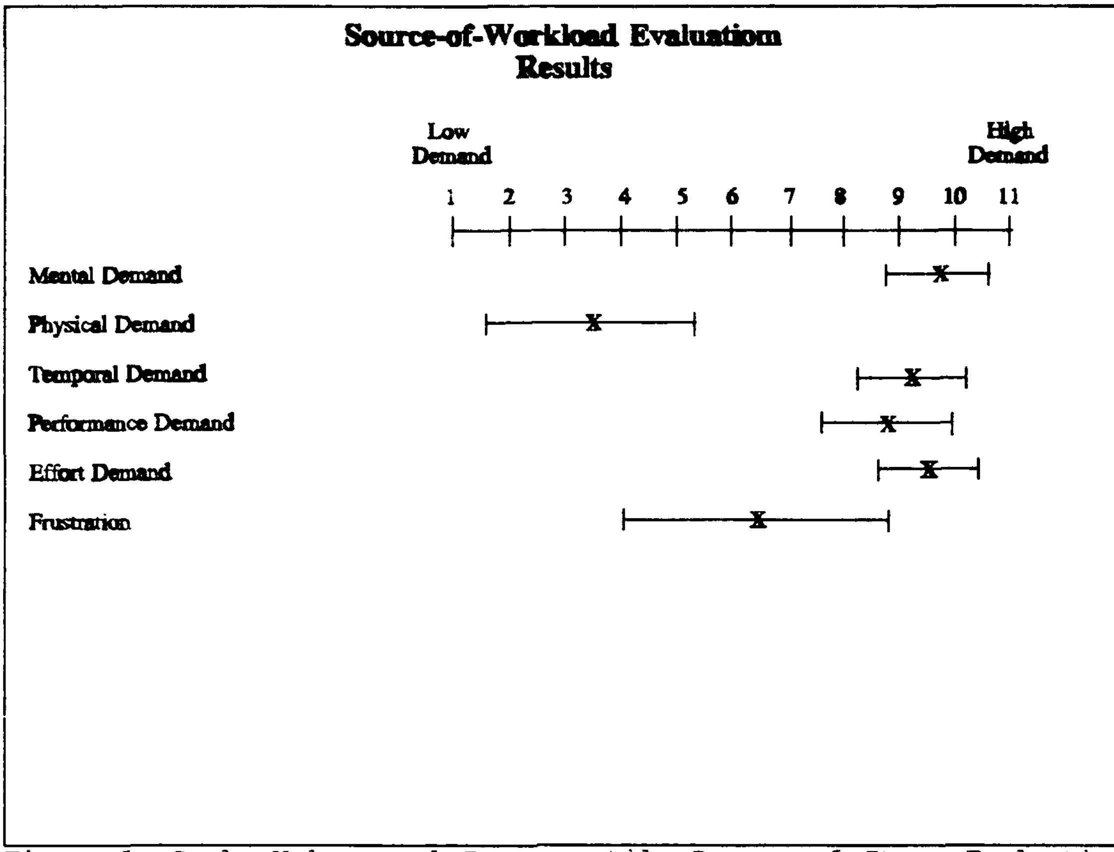

Figure 6: Scale Values and Interquartile Ranges of Items Evaluating Student Impressions of Six Human Workload Demand Dimensions

four instructors formed their opinion on the system by:

- Personally completing two scenario runs, and
- Observing the other instructors assisting students during their practice and test sessions.

This could account for their neutral sentiments for:

- How easily the IDCTT allowed them to instruct students,
- How realistic the IDCTT Trainer was, and
- The extent they would have liked to see the IDCTT Trainer permanently installed at the DCA School.

Instructor interviews revealed that the reason for the neutral response concerning the permanent installation of the IDCTT Trainer at the DCA School was that ***a clear mission in the school's curriculum was not clearly defined***. Since the system was not formally programmed to replace the DC Central Trainer, some instructors were not supportive of a separate IDCTT

Trainer requirement. ***They did acknowledge, however, the students' positive acceptance of the system*** (S = 7.50; IQR = 1.50).

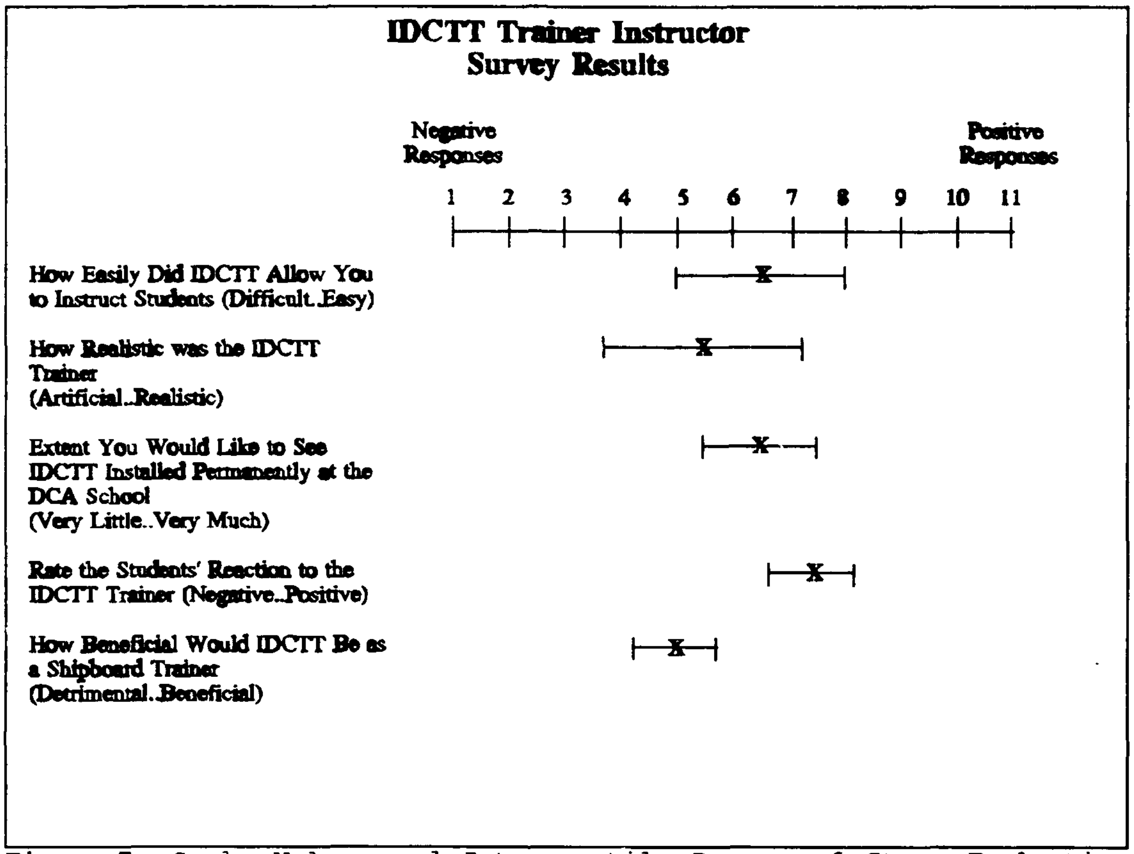

Figure 7: Scale Values and Interquartile Ranges of Items Evaluating Instructor Impressions of Five IDCTT Trainer Design Features

B. IDCTT VERSUS DC CENTRAL TRAINER PERFORMANCE COMPARISON

The DC Central Trainer provided a clear-cut baseline against which to compare the IDCTT Trainer. Since students were exposed to each system in a 24 hour period, they responded to the *IDCTT Trainer vs DC Central Comparison Survey* with recent experience in using each system. Further, ranking the importance of various damage control fundamentals using the *Scenario Topics Ranking Survey*, provided a measure for assessing the differing importance they attributed to 13 fundamental damage control topics for each trainer. Once the level of importance for each of these topics was established, the topics' relative importance for each of the two trainers was compared to determine which method provided a more

standardized scenario. Finally, the performance grades provided a simple way to evaluate student effectiveness in using the two trainers to combat the same battle problem. These comparisons are discussed below.

1. Student Trainer Comparison

Results from each category on the *Comparison Survey* clearly indicated that students preferred the IDCTT Trainer over the present DC Central Trainer. The most emphatic response from this comparative survey was the computed scale value of 1.39 which indicated that ***the IDCTT Trainer is, by far, the preferred training method.***[37] Respondents also strongly indicated that ***the IDCTT Trainer promoted greater learning, produced significantly more stress, and stimulated them to learn much more than the DC Central Trainer did*** (S = 2.38, 2.50, and 2.38; IQR = 2.47, 3.26, and 2.47, respectively). Many students described a greater sense of accomplishment after completing the IDCTT Trainer, since it seemed more challenging. Although the instructors felt that the IDCTT Trainer did not significantly increase their ability to evaluate student performance, the students themselves strongly felt that the IDCTT Trainer provided the instructor with a better method to assess their problem solving performance (S = 2.71; IQR = 2.50).

Responses on three of the comparison survey questions yielded no consensus among student responses. These questions were:

- Method which better prepares students for shipboard casualties (S = 4.06; IQR of 4.29),
- Easier method to initiate actions (S = 3.83; IQR of 6.00), and
- Method with the most realistic information presentation (S = 4.50; IQR of 4.50).

These three items, and their attendant variability, appeared to be based two schools of thought on how actions should be initiated, and information transferred in simulated battle problem training. One group of students preferred the Command Console's simulated shipboard environment and push

[37] Low values indicate a preference for the IDCTT Trainer while High values indicate a preference for the DC Central Trainer.

button displays. The other group felt that the interaction among watchstanders was a key portion of the training experience and preferred using numerous Sound Powered Phone Talkers to relay and receive information. *The critical design feature upon which these responses depended, however, was how much difficulty students had when they used the touchscreen monitor.* Those who experienced difficulties using the touchscreen, preferred the DC Central Trainer method of initiating actions through Sound Powered Phone Talkers. Students who did not experience problems with the touchscreen, preferred the IDCTT Trainer's method. Preferences were clearly related to the users mastery of the touchscreen features. Figure 8 graphically displays the student responses across the 11 comparative dimensions.

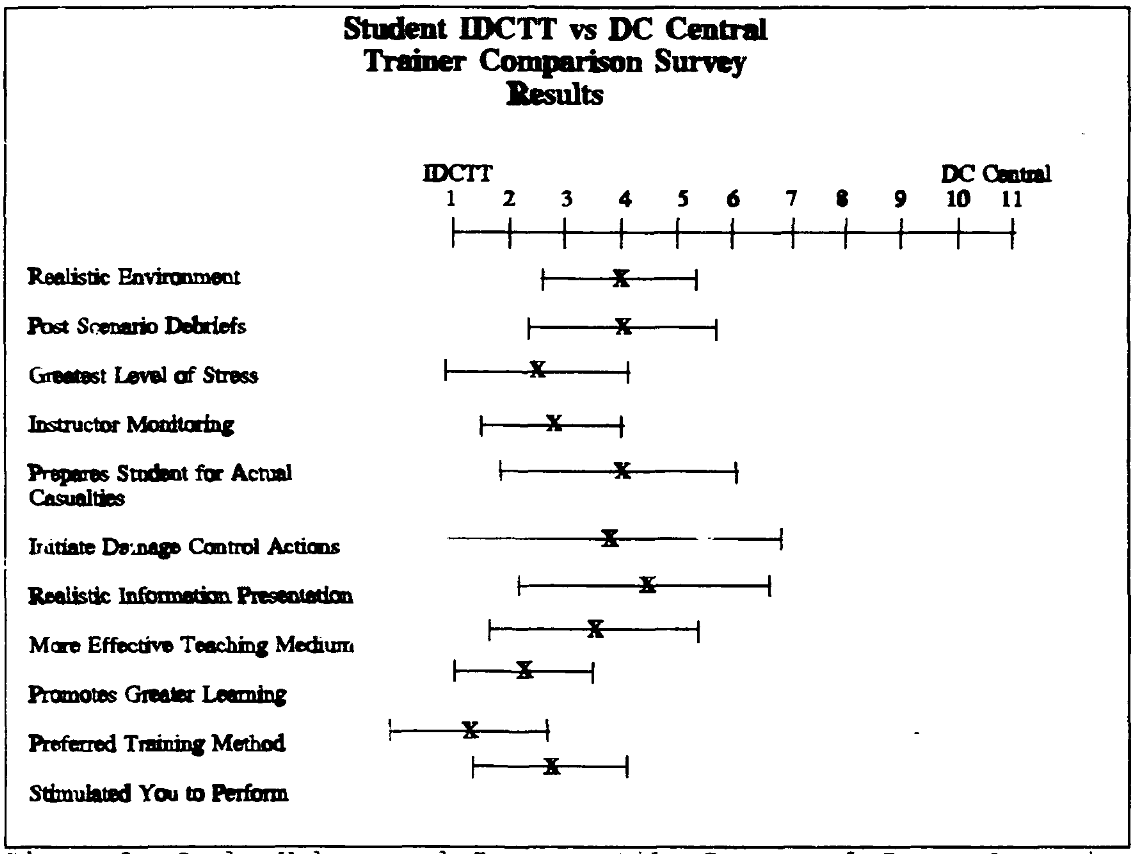

Figure 8: Scale Values and Interquartile Ranges of Items Comparing Student Impressions of 11 Trainer Design Features

2. Student Performance Grades

Student performance grades, collected from the two training methods, were used to determine which method provided a better environment in which students performed. As discussed previously, the scenario difficulty level was judged to be the same and students were graded using the same grading criteria for each method.[38] The Wilcoxon Signed-Rank Test for a Paired Experiment was used to determine if the relative frequency distribution of student performance scores were identical, or if the IDCTT Trainer scores were higher than the DC Central Trainer scores. The results of this test identified which medium promoted higher student performance. Table 16 summarizes the results of this test while a complete set of calculations is included in Appendix C.

TABLE 16: WILCOXON SIGNED-RANK TEST SUMMARY FOR STUDENT PERFORMANCE SCORES FROM THE IDCTT AND DC CENTRAL TRAINERS

Null Hypothesis: H_o: The population distributions for the IDCTT Trainer and the DC Central Trainer performance scores are identical.

Alternative Hypothesis: H_a: The population relative frequency distribution of the IDCTT Trainer's performance scores is shifted to the right of the DC Central Trainer's performance scores.

Test Statistic: $z = 1.99$

Rejection Region: Reject H_o if $z \geq z_\alpha$
where $z_\alpha = 1.96$ at the .025 significance level

Conclusion: Reject H_o and accept H_a at the .025 significance level.

The Wilcoxon Signed-Rank Test indicated that ***the frequency distribution of scores received using the IDCTT Trainer were higher than those scores received using the DC Central Trainer (.025 ≤ P ≤ .01).*** The higher scores obtained from the IDCTT Trainer can be attributed at least three factors which are discussed below.

[38] Appendix A provides a copy of the student grading criteria used in the study.

a. Student Preference for the IDCTT Trainer

That students preferred the IDCTT Trainer to the DC Central Trainer was clearly reflected by the scale values from the Comparison Survey. In particular, they held that the IDCTT Trainer promoted greater learning, and stimulated them to perform to the best of their ability. Higher test scores, therefore, could be accounted for by students who were simply more motivated to perform in the IDCTT Trainer. In their narratives and verbal remarks after the evaluation period, students indicated that the clear flow of information associated with the IDCTT Trainer was critical to their success. Conversely, in the DC Central Trainer, students reported that they were dependent on the abilities of their Phone Talkers to relay the correct information, a dependency which sometimes hindered the timely flow of accurate information.

b. System Stress

The IDCTT Trainer was designed to induce significant amounts of stress on students through the rapid pace of the scenario and the content of various audio and visual stimuli. The subject of performance under stress is not the focus of this paper, but it was readily observed that ***students who were exposed to the stressful IDCTT scenario appeared to concentrate more intently, and try harder*** to successfully complete the battle problem than when operating in the less stressful DC Central Trainer environment. When in the less stressful DC Central Trainer, participants projected a lax attitude toward completing the battle problem, and in general, did not seem to take the scenario as seriously as they did while executing the IDCTT scenario. The degree to which students became engrossed in the scenario seemed to correspond with their performance scores.

c. Grading Expectations

Before the test period, performance scores were expected to be higher in the DC Central Trainer due to students' familiarity with the system and the concerted problem solving methods the group trainer

allowed. Two factors discounted this expectation. First, ***students quickly became familiar with the IDCTT Trainer***. Most students adeptly operated the IDCTT Trainer by the end of the practice session, and by the graded session, each student completed all required actions without outside assistance. The speed with which students adapted to the computer simulation quickly eroded any advantage the DC Central Trainer conferred because of its familiarity. Second, when students were removed from the group atmosphere of the DC Central Trainer, ***they assumed greater responsibility in solving the problem and decision making became more spontaneous***. The quality of decisions did not significantly differ between the two systems; per se, however, the speed with which decisions were made was much quicker in the IDCTT Trainer. Thus, the DCA's performance did not seem to be hindered by not having a watchteam to suggest various damage control actions.

d. Summary

Based on student performance, the IDCTT Trainer is a more effective training medium. Students were more motivated to perform, and preferred the methods used by the IDCTT Trainer to deliver simulated battle problems. The IDCTT Trainer allowed the instructor to carefully monitor student performance by eliminating the need for the instructor to spend much of his time initiating the scenario rather than critiquing it. Unlike the DC Central Trainer, where the instructor is removed from the student training area, the IDCTT instructor is positioned to critique and assist the student in the training area.

3. Trainer Type Scenario Variation

Developing a procedure to measure the level of variation induced by each method over many repetitions of the same scenario was difficult. The objective of this portion of the study was to measure the extent to which each trainer consistently delivered a standardized scenario. Clearly, reducing the level of variation between repetitions so each student is given the same difficulty level in which to train is desirable.

Likewise, reducing the subjectivity in assigning performance scores between training periods with varying levels of difficulty is desirable from a methological perspective. That students would feel the computer simulation would provide more consistent training scenarios was expected because the computer generated scenario did not rely exclusively on the instructor's ability to present the scenario, as is the case with the DC Central Trainer. The IDCTT Trainer is physically programed to execute a series of events which presents the same scenario each time.[39] Alternately, the DC Central Trainer's scenario, which relies on the instructor to create the training environment, differs between trials for four important reasons:

- Instructors do not follow a specific time-line when initiating the scenario,
- Instructors are given a script of events but are free to execute each event in his own training style,
- Instructors often adjust the scenario difficulty level to meet student performance level, and
- Students can request additional information from the instructors, which is not an option with the IDCTT Trainer.

The measures used to analyze the level of variation present in each trainer type were the scale values and interquartile ranges calculated from responses on the *Scenario Topics Ranking Survey*. These two measures are more fully discussed below.

a. *Scale Value Assessment*

The numerical index used to evaluate the variability in the two methods reflected the degree each method emphasized the various fundamental damage control actions required to complete the scenario. The *Scenario Topics Ranking Survey* required students to rate how important each of 13 fundamental damage control topics was in completing the scenario. The topics for each of the two systems were assigned ranks based on scale values obtained by the *Scenario Topics Ranking Survey*.

[39] The scenario does differ depending on the actions taken by the student.

Since the scenarios were the same for the two trainers, the scale values assigned for each topic should have been approximately the same.

Simply stated, the ranks for the two systems tracked closely, except for communications, which was ranked the eleventh most important for the IDCTT Trainer and the third most important for the DC Central Trainer. Scale values for each topic fell within one point for each of the topic between the two methods with the exception of:

- Communications, and
- Keeping the chain of command informed,

which differed by only 2.05 and 1.14 points respectively. Figure 9 displays the scale values obtained for the two trainer types. The figure highlights the more pronounced emphasis, as determined by the scale values, for the topics using the IDCTT Trainer. These scale values indicate that students felt the degree with which each topic was emphasized was more pronounced using the IDCTT Trainer.

(1) Ranking Differences. As shown in Figure 9, communications and keeping the chain of command informed, are given different priorities in the two systems. The content of student narratives revealed that communications were not emphasized in the IDCTT Trainer because they did not feel the touchscreen input device effectively tested, or even required, their communication skills. Students felt the DC Central Trainer's group environment, combined with use of Sound Powered Phone Talkers to exchange information, emphasized the need for well practiced communication skills.

Students identified problems exchanging information with the Bridge and the Commanding Officer as a communication deficiency in the IDCTT Trainer. This shortcoming may have induced students to feel that keeping the chain of command informed was not a high priority in the IDCTT Trainer. Conversely, the instructor in the DC Central Trainer, acting as the Bridge and the Commanding Officer, continually prompted the student for information, thus creating a distinct need to keep the chain of

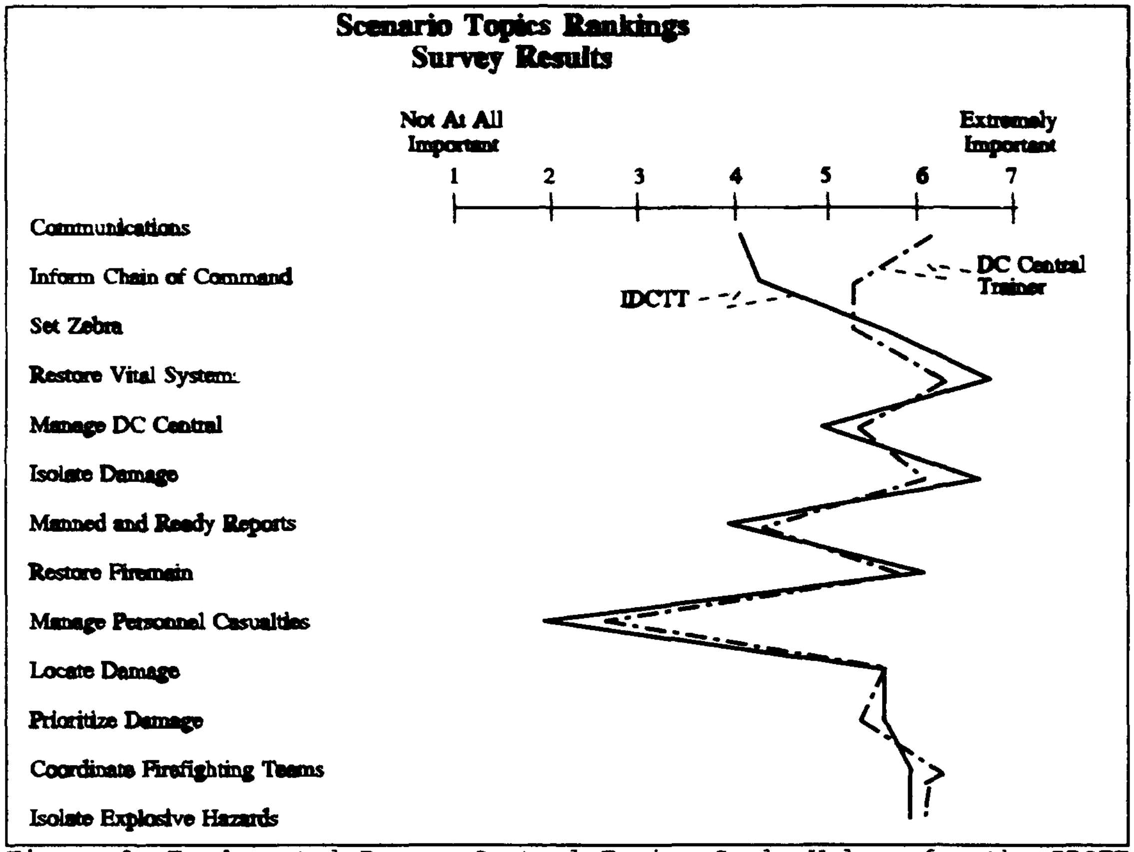

Figure 9: Fundamental Damage Control Topics Scale Values for the IDCTT and DC Central Trainers

command informed. Although the data did not indicate which method was more variable, it did demonstrate that each method emphasized the same damage control fundamentals with the exception of communications.

b. Interquartile Range Assessment

Overall, response variability for the IDCTT Trainer was higher than the DC Central Trainer. As shown in Figure 10, nine out of the 13 topics (69 percent) had a higher IQR value for the IDCTT Trainer. ***Students' assessment of how important each topic was in completing the scenario varied more for the IDCTT Trainer.*** If, in fact, grading the 13 damage control topics is a valid measure of effectiveness for evaluating system variability, this would indicate that the scenario produced using the DC Central Trainer is less variable than the IDCTT Trainer. This finding is contrary to the logical expectation that the computer

simulation is more suitable, by design, for providing identical training scenarios. If the IDCTT Trainer actually provides more consistent scenarios, then either the measures of effectiveness for evaluating system variation are incorrect or the testing methods for soliciting students responses were unclear or not the best method possible. Further data and analysis of the systems' variation in producing consistent training scenarios is required.

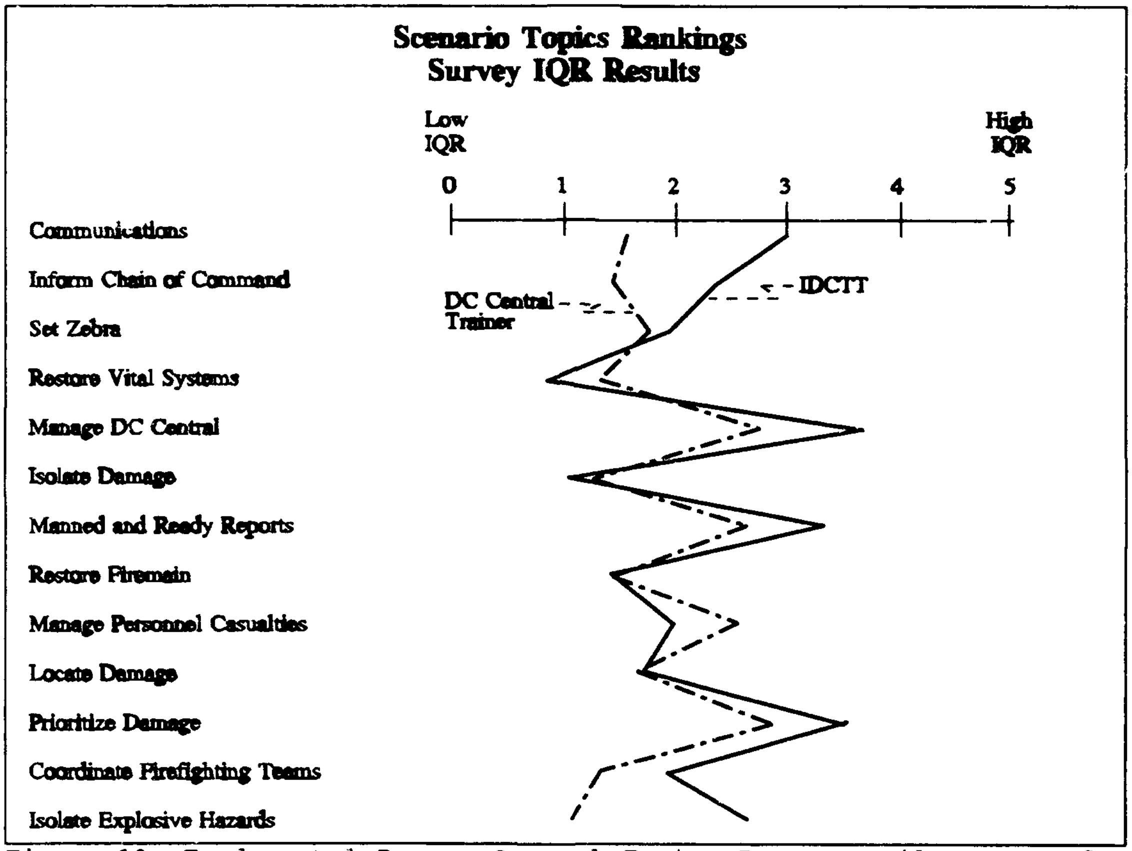

Figure 10: Fundamental Damage Control Topics Interquartile Ranges for the IDCTT and DC Central Trainers

C. Summary

The data collection plan provided sufficient information to conduct the validation analysis. An analysis of collected data indicated that the IDCTT Trainer is an effective training tool, however there are areas where

improvements can be made. The following chapter summarizes the findings of this validation study.

V. CONCLUSIONS

The findings of this validation indicate that the IDCTT Trainer is a highly effective training aid in a shore based environment. Students not only reported that felt the IDCTT Trainer was easy to operate and extremely useful as a training aid at the Damage Control School, they indicated they would like to see the trainer made available for shipboard use. When compared to the DC Central Trainer on specific design features, respondents indicated a clear preference for the IDCTT Trainer on every dimension examined. Further, the distribution of actual performance scores taken from the two different trainers revealed that the IDCTT Trainer is clearly the more effective training medium. The following sections encapsulate this study's major findings from both the IDCTT Trainer performance evaluation and the IDCTT versus DC Central Trainer performance comparison.

A. IDCTT TRAINER PERFORMANCE EVALUATION

Taken together, the data from the IDCTT Trainer performance evaluation revealed that the system was enthusiastically accepted by the student test group. While instructors themselves were neutral in their impression of the IDCTT Trainer, they indicated that their students reacted positively to the system. The results from this circumscribed portion of the study were presented in two broad categories; IDCTT Trainer performance attributes, and suggested areas of improvement. The findings from these topics are summarized.

1. IDCTT Trainer Performance Attributes

Students indicated that the IDCTT Trainer was an extremely effective training aid and the IDCTT Trainer performance evaluation specified the following desirable attributes.

- Students liked the IDCTT Trainer concept and design.
- The IDCTT Trainer was easy to operate.

- The trainer was consistently considered useful as a DC School training aid or as a potential shipboard training aid across all students surveyed.

- Student responses were clearly favorable to the IDCTT on each of the eight conventional interactive courseware dimension presented.

- The scenario was easy to understand and was extremely realistic.

- Audio and visual effects created by the trainer were identified as the main reasons why the trainer was so successful in creating what the students considered to be a realistic training scenario.

- The students' prevailing experiences that the scenario was difficult reflected the designers original intentions: the exercise was to be difficult.

- Scenario objectives were clearly defined.

- Respondents rated the system as mentally and temporally demanding while requiring a high level of effort to complete the IDCTT Trainer scenario.

- Instructors acknowledged the students' positive acceptance of the system.

- Students quickly became familiar with the IDCTT Trainer.

2. Improvement Items

Although the IDCTT Trainer was agreed upon by the students to be an effective training medium, various characteristics of the trainer were identified for potential improvements. These areas identified by the validation study are listed below.

- Most of the problems identified with the system were rooted in inputing information into the system using the touchscreen monitor.

- Fifty-nine percent of the students indicated they experienced some difficulty operating the touchscreen monitor.

- The touchscreen's primary problem was its low sensitivity to touch and its slow response time.

- An accidental input into the touchscreen monitor could seriously affect the student's performance by causing them to focus their attention on repeating the button process rather than the flow of information from the various sources.

- Students recommended increasing the sensitivity of the touchscreen or exploring different methods for inputing information into the system such as voice activation.

- Thirty-eight percent of the students indicated they had problems with the pace of information flow. However, most students appeared to be comfortable with the pace by the time they reached their graded session.

- Students and Instructors indicated the need for more scenarios with different ship classes to support the diversity of fleet experience.

- The main problem identified with the Firemain Panel was the small display screen.

- Students often overlooked critical indications on the Firemain Panel because they simply did not notice any changes in its compact display.

- Students suggested a demonstration tape to provide a step by step sequence through the various options in order for the students to familiarize themselves with the system more quickly.

- For audio reports, respondents indicated that they became distracted by erroneous information in the background audio track.

- Fourteen of the 32 students did not complete the scenario due to chill water related problems.

- The Damage Control School should review its course curriculum and place a stronger emphasis on the chill water system if the curriculum is to reflect the shift in fleet doctrine toward the TSS philosophy.

- Some instructors were concerned that the IDCTT Trainer lacked a clear mission in the school's curriculum.

B. IDCTT VERSUS DC CENTRAL TRAINER PERFORMANCE COMPARISON

The IDCTT versus DC Central Trainer performance comparison was used to measure the IDCTT Trainer's performance against the DC Central Trainer. This portion of the study revealed that students felt that the IDCTT Trainer was the preferred training method in every category examined. Specifically, the following keynotes were identified.

- The IDCTT Trainer is by far the preferred training method.

- The IDCTT Trainer promoted greater learning, produced significantly more stress, and stimulated Students to learn much more than the DC Central Trainer did.

- The frequency distribution of scores received using the IDCTT Trainer were higher than those scores received using the DC Central Trainer at the .025 significance level.

- Based on student performance, the IDCTT Trainer is a more effective training medium.

- When students were exposed to the stressful IDCTT scenario, they appeared to concentrate more intently, and try harder than during the DC Central Trainer sessions.

- Students assumed greater responsibility in solving the scenario and decision making became more spontaneous while exercising in the IDCTT training environment.

- Students' assessment of how important each fundamental damage control topic was in completing the scenario varied more for the IDCTT Trainer, indicating less standardized scenarios than the DC Central Trainer.

- Instructors felt that the IDCTT Trainer better prepared the DCA students for the actual damage control situations they will face in the fleet.

APPENDIX A SURVEYS

The following surveys were the surveys used in support of the data collection plan. All seven surveys and grade sheets which were used in the study are included in this Appendix.

STUDENT IDCTT SURVEY

NAME ______________________ **DATE** ______________________

RANK ______________________ **YEARS OF SERVICE** ______________________

YEARS ENLISTED SERVICE __________ **PRIOR ENLISTED RATE** ______________

WHAT SHIPS HAVE YOU SERVED ON? ______________________ **HOW LONG** ______

______________________ ______

______________________ ______

______________________ ______

______________________ ______

Have you served as a Damage Control Assistant for 6 months or more (**CIRCLE ONE**)? Yes No

Have you served as repair 2, 3 OR 5 Locker Officer for 6 months or more (**CIRCLE ONE**)? Yes No

---

Your answers to the following questions will help improve the quality of training you receive in the Damage Control Central Simulators. **Please answer the following questions completely, explaining your answers thoroughly**. Use the Back of the questionnaire if additional answer space is required. Upon completion, please return this survey to your instructor.

---

1. Approximately how much time did you spend using IDCTT?

   ______ hours

2. Have you used interactive video courseware such as the IDCTT system before? (CIRCLE ONE) Yes No

   If yes, what courseware did you use? (use back if necessary)

3. Rate **how difficult or easy** the **IDCTT System** was to operate?

Very Difficult				Neutral						Very Easy
1	2	3	4	5	6	7	8	9	10	11

4. Check any of the following operations which caused you difficulty while operating the IDCTT System.

   ___ Inputing information with the touchscreen monitor

___ Understanding audio reports

___ Finding DC plate information with ISMS (examples: compartment and valve numbers)

___ Speed or volume of information presented (did you easily lose track of the situation due to the speed or volume of information flow)

___ Damage control alarm panel display

___ Firemain panel and firemain valve and pump options

___ Other (please specify):

5. In the space provided below, briefly explain why the items you checked caused you difficulty.

6. Rate the extent to which the touchscreen **allowed you to input the information** necessary to combat the Damage Control scenario.

All of the Information ... ***Neutral*** ... ***None of the information***
1 2 3 4 5 6 7 8 9 10 11

7. Rate **how easily** the touchscreen allowed you to input information

Very Difficult ... ***Neutral*** ... ***Very Easily***
1 2 3 4 5 6 7 8 9 10 11

8. How can the touchscreen control panel be improved?

9. Rate the IDCTT Scenario according to the following criteria (note: this question refers to **the battle problem** itself and **not the IDCTT system as a whole**).

Too Easy ... ***Neutral*** ... ***Too Difficult***
1 2 3 4 5 6 7 8 9 10 11

Very Confusing ... ***Neutral*** ... ***Very Easy to Understand***
1 2 3 4 5 6 7 8 9 10 11

Too Fast ... ***Neutral*** ... ***Too Slow***
1 2 3 4 5 6 7 8 9 10 11

Very Realistic ... ***Neutral*** ... ***Very Unrealistic***
1 2 3 4 5 6 7 8 9 10 11

10. What problems did you encounter while using the IDCTT trainer?

11. What aspects of the IDCTT Trainer do you like the most?

12. What aspects of the IDCTT Trainer do you like the least?

13. Rate **how useful** the IDCTT Trainer is as simulation training aid for students **at the Damage Control School**?

Very Useful					***Neutral***					***Completely Worthless***
1	2	3	4	5	6	7	8	9	10	11

14. Rate **how beneficial** the IDCTT Trainer would be as an **installed shipboard** training aid.

Very Beneficial					***Neutral***					***Completely Detrimental***
1	2	3	4	5	6	7	8	9	10	11

SUBJECT INSTRUCTIONS AND SURVEY:
SOURCES-OF WORKLOAD EVALUATION

Throughout this experiment the rating scales are used to assess you experiences in the different tasks conditions. Scales of this sort are extremely useful, but their utility suffers from the tendency people have to interpret them in individual ways. For example, some people feel that mental or temporal demands are the essential aspects of workload regardless of the effort they expended or the performance they achieved. Others fell that if they performed well the workload must have been low and vice versa. Yet others feel that effort or feelings of frustration are the most important factors in workload; and so on. The results of previous studies have already found every conceivable pattern of values. In addition, the factors that create levels of workload differs depending on the tasks. For example, some tasks might be difficult because the must be completed very quickly. Others may seem easy or hard because of the intensity or mental or physical effort required. Yet others feel difficult because they cannot perform well, no matter how much effort is expended.

The evaluation you are about to perform is a technique that has been developed by NASA to assess the relative importance of six factors in determining how much workload you experienced. The procedure is simple: Read the following task descriptions and then mark the scale at the point that reflects the task load that you experienced. If you have any questions, please ask them now. Thank you for you participation.

Title	**Endpoints**	**Descriptions**
Mental Demand	Low/High	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
Physical Demand	Low/High	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious
Temporal Demand	Low/High	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
Effort	Low/High	How hard did you have to work (mentally and physically) to accomplish your level of performance?
Performance	Low/High	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
Frustration	Low/High	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

MENTAL DEMAND

How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking searching, etc.)? Was the task easy or demanding, simple or complex. exacting or forgiving?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

PHYSICAL DEMAND

How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

TEMPORAL DEMAND

How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

PERFORMANCE DEMAND

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

EFFORT DEMAND

How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

FRUSTRATION

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Low										**High**
1	2	3	4	5	6	7	8	9	10	11

USER INTERFACE DIMENSIONS

Directions: A number of statements which describe the Interactive-video Courseware (ICW) are given below. Read each statement and then make circle the number which reflects your opinion. There are no right or wrong answers.

Dimension 1 - Ease of Use
(perceived facility with which user interacts with the ICW)

Difficult										**Easy**
1	2	3	4	5	6	7	8	9	10	11

Dimension 2 - Navigation
(perceived ability to move through the contents of the ICW)

Difficult										**Easy**
1	2	3	4	5	6	7	8	9	10	11

Dimension 3 - Cognitive Load
(Perceived degree that the user interface seems manageable)

Unmanageable										**Manageable**
1	2	3	4	5	6	7	8	9	10	11

Dimension 4 - Mapping
(Program's ability to track and graphically represent user's path through the program)

None										**Powerful**
1	2	3	4	5	6	7	8	9	10	11

Dimension 5 - Knowledge Space Compatibility
(Network of concepts and relationships that compose the user's knowledge about the topic)

Incompatible										**Compatible**
1	2	3	4	5	6	7	8	9	10	11

Dimension 6 - Information Presentation
(Perceived degree that the information contained in the ICW is presented in an understandable form)

Obtuse										**Clear**
1	2	3	4	5	6	7	8	9	10	11

Dimension 7 - Media Integration
(How much does the ICW coordinate the different media to produce an effective whole)

Uncoordinated										**Coordinated**
1	2	3	4	5	6	7	8	9	10	11

Dimension 8 - Overall Functionality
(Perceived utility of the ICW in relation to the program's intended use)

Dysfunctional									**Highly functional**	
1	2	3	4	5	6	7	8	9	10	11

IDCTT INSTRUCTOR SURVEY

NAME ______________________ **DATE** ______________________

RANK ______________________ **YEARS OF SERVICE** ______________

TIME AS AN INSTRUCTOR AT DCA SCHOOL ______________________

Your response to the following items will help modify the IDCTT program to more specifically address your Command's training goals. This survey is designed to assess how instructors rate different aspects of the IDCTT Trainer effectiveness. There are also short answer questions where you can express your opinion on the system. **Please answer all of the questions completely, explaining your answers thoroughly**. Use the back of the questionnaire if additional answer space is necessary.

1. Approximately how many hours did you spend assisting students with the IDCTT Trainer?

______ Hours

2. From an instructor's perspective, rate **how easily** the IDCTT Trainer allowed you to instruct students in damage control simulator training.

Very Easy					***Neutral***					***Very Difficult***
1	2	3	4	5	6	7	8	9	10	11

3. Rate **how realistic** the IDCTT Trainer depicts damage control training compared to actual shipboard damage control.

Very Realistic					***Neutral***					***Very Artificial***
1	2	3	4	5	6	7	8	9	10	11

4. Rate the extent to which you would like to see the IDCTT Trainer used as a **permanent aid** for simulation training at the DC School.

Very Much					***Neutral***					***Very Little***
1	2	3	4	5	6	7	8	9	10	11

5. Rate the **students reaction** (positive or negative) to the IDCTT Trainer as an instructional aid.

Very Positive					***Neutral***					***Very Negative***
1	2	3	4	5	6	7	8	9	10	11

6. Rate **how beneficial** the IDCTT Trainer would be as an installed shipboard training tool.

Very Beneficial					***Neutral***					***Very Detrimental***
1	2	3	4	5	6	7	8	9	10	11

7. What aspects did you like about the IDCTT for teaching damage control problems?

8. What problems did you encounter while using the IDCTT as an instructional aid?

9. What aspects of the IDCTT would you like to see changed?

10. What benefits do you envision from the use of IDCTT at the Damage Control School?

STUDENT GRADE SHEET FOR IDCTT AND DC CENTRAL TRAINER SCENARIOS

STUDENT'S NAME (DCA) ______________________ **DATE** ____________________

GROUP MEMBER NAMES ______________________ ______________________

______________________ ______________________

______________________ ______________________

INSTRUCTOR'S NAME ______________________

METHOD (CIRCLE ONE): IDCTT DC CENTRAL TRAINER

The following is a grade sheet for IDCTT and DC Central Trainers. The results will be used for research purposes only! Grades assigned using this evaluation form **<u>will not effect student grades in any capacity</u>**. This performance evaluation will be used for the sole purpose of comparing the IDCTT and DC Central Trainer methods.

Maximum points allowed for each topic are indicated in parentheses next to each topics. Partial credit may be awarded when actions are taken for a topic area but not completely or correctly executed. For example, if fire boundaries were successfully set on 3 of 5 spaces requiring this action, the student would receive 6 out of a possible 10 points. The instructor will determine what percentage of the topic area was accomplished and assign points accordingly.

---

1. DCA ensured zebra was set on firemain _____ (5 points)

2. Investigators sent out to investigate ruptured piping when pressure indications suggested a rupture. _____ (5 points)

3. Maintained firemain pressure through isolating damaged spots and firepump management. _____ (5 points)

4. Investigators sent out to investigate all fire and flooding alarms. _____ (5 points)

5. Fire boundaries set around compartments on fire. _____ (10 points)

6. Smoke boundaries set around compartments on fire. _____ (5 points)

7. Flooding boundaries set around flooding flooded compartments. _____ (10 points)

8. Priority focused on fires/floods near key spaces (i.e., magazines, radar equipment, CIC). _____ (10 points)

9. Efforts made to fight fires with assets available. _____ (5 points)

10. Efforts made to isolate ruptures (non firemain i.e., chill water, fuel, lube oil). _____ (5 points)

11. Attempts made to repair damage when identified (i.e., ruptured chill water, ruptured firemain). _____ (5 points)

12. When prompted for action did the DCA respond in an effective and timely manner (from repair lockers, bridge, CIC). _____ (5 points)

13. Response to prompts from CSMC on loss of chill water or overheating arrays radars. _____ (10 points)

14. Maintain the big picture of the damage and circumstances that he was combating. _____ (10 points)

15. Keep the Commanding Officer bridge informed on the status of damage control efforts. _____ (5 points)

TOTAL POINTS SCORED _____ (100 points)

Comments:

STUDENT IDCTT VS DC CENTRAL TRAINER COMPARISON SURVEY

NAME ______________________ **DATE** ______________________

RANK ______________________

Your answers to the following questions will help improve the training you receive in Damage Control Central simulators. This survey will provide information for comparing the effectiveness of the IDCTT Trainer and DC Central Trainer as a training aids. This survey is designed to determine your opinion on the ability of the IDCTT and DC Central Trainers to provide quality training. **If you have any comments that the numerical scale do not address, please write your comments on the back of the survey.** Upon completion, please return this form to your instructor.

1. Rate which method provides a more realistic model of an actual shipboard damage control environment.

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

2. Rate which method provides the ability for the instructor to provide the most complete post scenario debriefs.

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

3. Rate which method produced the greatest level of stress while performing the damage control scenario.

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

4. Rate which system enabled the instructors to monitor student performance more closely.

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

5. Rate which method will better prepare you for the actual casualties that might encounter while onboard a ship.

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

6. Rate which method provides an easier means to take action on scenario problems (i.e., sound powered phones, DC plate plotting and hardwired alarm panels vise touchscreen inputs and computer monitor alarm panels)

IDCTT					*Neutral*				*DCC Trainer*	
1	2	3	4	5	6	7	8	9	10	11

7. Rate which method provides scenario information in a manner most closely resembling shipboard emergency situations.

IDCTT					***Neutral***				***DCC***	***Trainer***
1	2	3	4	5	6	7	8	9	10	11

8. Rate which method is more effective in teaching damage control skills necessary to combat damage control problems

IDCTT					***Neutral***				***DCC***	***Trainer***
1	2	3	4	5	6	7	8	9	10	11

9. Rate which system promoted greater learning in the amount of time allocated.

IDCTT					***Neutral***				***DCC***	***Trainer***
1	2	3	4	5	6	7	8	9	10	11

10. If you had access to one method of instruction rate which system you would prefer.

IDCTT					***Neutral***				***DCC***	***Trainer***
1	2	3	4	5	6	7	8	9	10	11

11. Rate which method inspires you to perform to the best of your ability.

IDCTT					***Neutral***				***DCC***	***Trainer***
1	2	3	4	5	6	7	8	9	10	11

SCENARIO TOPICS RANKING

NAME________________________________ **DATE**____________________

THIS RANKING IS FOR (**CIRCLE ONE**): IDCTT SCENARIO

DC CENTRAL TRAINER SCENARIO

The following thirteen topics summarize the principal actions necessary to successfully complete a damage control problem. The instruction method to which you were just exposed emphasized each of the following topics to varying degrees. In the blank space provided to the left of each topic, **rank each topic from 1 to 7** based on how you felt the method (IDCTT or DC Central Trainer) emphasized the **importance of each topic to complete the DC problem**. Use the following criteria to express your opinion:

Not At All Important			*Neutral*			*Extremely Important*
1	2	3	4	5	6	7

<u>**NOTE:**</u> Base your rankings on what the **scenario emphasized** and **not on what you think should be emphasized.**

_____ Maintain effective communications

_____ Keep the chain of command informed

_____ Ensure Zebra is set

_____ Restore vital systems (i.e., mechanical, chill water, ventilation)

_____ Manage Damage Control Central

_____ Isolate damage (smoke, fire and flood boundaries)

_____ Confirm proper manned and ready reports

_____ Restore Firemain

_____ Manage personnel casualties and evacuations

_____ Locate damage

_____ Prioritize casualties

_____ Coordinate firefighting and repair teams

_____ Isolate explosive hazards (i.e., magazines, fuel tanks)

IDCTT Trainer Survey Question 5

Briefly explain why any of the below listed IDCTT Trainer features caused you difficulty while operating the system.

A. *Inputing information with the touchscreen monitor*

Trying to input information rapidly with large fingers on a relatively small screen.

More distance needed between touchscreen buttons to avoid accidental inputs.

Touchscreen needs to be more sensitive.

Touchscreen did not always take information first time it was entered.

Too slow when ordering actions.

Touchscreen responded too slowly.

Touchscreen looked like it activated only to find out that it did not.

Difficult to press correct buttons.

Missed information while typing in orders on the touchscreen.

Screen did not respond promptly to inputs.

Had difficultly getting to appropriate menu.

Did not know if orders were accepted.

Difficult to input data.

Difficult inputing information.

Did not take information inputs.

Hard to get used to touchscreen.

Due to the speed of the scenario it was difficult to input necessary information in time given.

Unfamiliarity with the inputing system and the ship involved made it difficult to enter information.

Touchscreen was not very sensitive, I usually had to hit the screen 2 times to activate the option.

Sometimes you had to touch the screen two or three times to input information.

Events were overwhelming at times due to the slow data input rate.

It is easy to get overwhelmed by incoming information because you can not give immediate responses to the reports, so incoming reports mount up before the DCA can tell the computer what to do.

Entering data was difficult due to unfamiliarity with the sequencing logic and symbology. It got easier as the program progressed.

Some options were difficult to discern or are not activated.

B. Understanding audio reports

Background noise sounds like a report because it keeps saying, "DCA,....".

Background noise contained clearly erroneous information.

Could not ask for repeat of voice messages.

C. Finding DC plate information

Never had seen DDG-51 chill water or compartment DC Plates, which led to problems isolating systems.

Not used to DDG-51 Class.

DC Plates difficult to understand.

Could not find the valve numbers I wanted to close.

Could not locate the information needed.

D. Speed or volume of information presented

Too fast for a beginner, need to be able to adjust speed with which information is given.

Speed of information presented overloads the DCA at first.

Too many printed messages.

Lost track of audio reports and tried to key on important issues.

Massive volume of data was difficult to track and remember but this seems to make the simulation more realistic.

E. Damage control alarm panel display

No responses.

F. Firemain panel and firemain valve and pump operations

The firemain panel is busy and it goes by fast.

Firemain screen is too small, can't read print.

Firemain panel, especially, fire pumps were difficult to read and understand.

G. Other

The initial five to ten minutes of the first run was just system familiarization.

Not able to find out the status of the chill water system.

Big trouble learning what actions the repair lockers, etc, were doing on their own and what I needed to direct. Also, what I had to tell lockers to get things done.

Lack of experience (my problem).

Tried to order a COV to Repair V when it was in the Repair III area. Computer just said, "review your last order" and did not say that the valve was not in their area. Locker should say, "That is in Repair III area Sir!".

The program will not accept spaces to investigate unless damage is reported in the space.

Unable to give space name to locker and let the locker look up the fire and flooding boundaries.

IDCTT Trainer Survey Question 8

How can the touchscreen control panel be improved?

I think it is fine.

The screen, at times, does not respond well.

Larger number pad on touchscreen, use keyboard instead.

Put more space in between buttons.

Increase touchscreen sensitivity.

Better touchscreen sensitivity.

Practice.

Make touchscreen more sensitive to the touch and quicker to respond.

Auto advance through "setting boundaries" after enter is pushed.

Teach the users the proper method of touching the screen.

Program a five to seven second pause into the system to input information. Voice activated commands would be best.

More sensitive with quicker response time.

Faster button response to the touch.

Touchscreen does not always "take" information when you push the area, other times you have to keep your finger on it for a long time before it accepts your input.

Difficult to enter information on screen, improve screen sensitivity.

Add an audio bell to indicate that the inputed information was accepted.

Use mouse control to increase speed.

Input information through the keyboard only.

Switch to a mouse.

Switch to voice activation.

Make status and repair keys give better information.

Use keyboard vice screen keypad.

Not all actions are acknowledged the same way causing multiple inputs.

Improve system so screen does not freeze up.

Improve sensitivity.

Voice activation of DCA orders.

IDCTT Trainer Survey Question 10

What problems did you encounter while using the IDCTT Trainer?

The Command Console number pad is slow in responding to inputs.

Unfamiliarity with DDG-51 systems.

No method for confirming actions ordered were taken. While inputing information into the system, I accidentally cancelled the input.

Inputing information through the touchscreen and background noise.

Dirty screen causing the computer to act funny. We cleaned the screen and everything was fine.

Learning what functions each button option would do.

Losing information inputed through the screen because I did not press "OK".

Initial system familiarization.

System froze to reload printer paper and some kind of memory error.

Coordinating all reports and correlating them to the various plots and displays.

No way of asking the status of boundaries being set.

Focusing energy on inputing information rather then the battle problem.

Unfamiliarity with the system, need more time to practice.

Lost control of the situation, typed in flooding boundaries when I wanted to set fire boundaries.

Lack of knowledge of chill water system killed me.

Inexperienced in making reports to the commanding officer.

Inputing information into the touchscreen.

Printer stalled during the battle problem.

System would lock-up for a couple of seconds for unknown reason.

Message blanks are good but too much information is given in the amount of time allotted to read them.

No clear means of reporting information to the Captain/Bridge.

Confusion caused by background noise that gave incorrect reports.

Lack of experience with equipment.

Finding the correct keys to touch.

Knowing what was done automatically. For example during beginning sequence, zebra on Firemain is reported set, but I had to order the valve closed.

Learning what to press to make reports to the Commanding Officer was difficult.

Lack of knowledge of how to use it.

Touchscreen sensitivity and becoming familiar with the computer.

Knowledge of the repair locker capabilities and what I had to tell them to carry out what I wanted, ex: fight for fighting fires.

Sometimes correct inputs were not understood by the computer (ie, fight fires 0-1 level was accepted but actual compartment number was not).

The magazine blew up even though I lit off the deluge system.

Lack of familiarity with the system.

Dirty screen caused faulty input responses. Unfamiliarity with command and control functions caused some confusion early on but became less of a problem as experience increased.

IDCTT Trainer Question 11

What aspects of the IDCTT Trainer did you like the most?

Trainer seems realistic.

Interactive aspects.

Clarity of information received.

Realistic flow of events and speed of damage. DCA gets an actual test rather than knowing what will happen.

Amount of stress induced by the system.

Good system for training, don't have to go to GQ to operate.

Audio was excellent and message blanks provided added realism.

Ability for one person to train without the ship going to GQ.

Being able to repeat a scenario until you get it right.

Audio and video messages.

Visually realistic representation of DC member images.

Pace and presentation of information.

Very realistic.

Clear information through printer messages.

Printed DC messages.

Video images of people telling you information.

Fast and furious flow of information seems fairly realistic.

Problems cascade if appropriate actions are not taken.

Fast paced audiovisual displays make you think quickly.

Repetition of the same scenario allows you to learn the proper sequence of actions to combat the damage.

Good training aid that focuses on the DCAs skill.

Visual display of actions taking place.

Real life feeling.

Speed and reality of scenario.

Realistic, fast paced, you as a student became very involved. I was impressed.

Stresses the DCA and starts preparing him for how he needs to think in DC Central.

Stress technical aspects of DC, such as boundaries and reenforces them much better then the DC Central Trainer.

Video display makes it look very realistic.

Sound effects and voice reports.

Video and audio effects.

One man trainer does not require any ship's assets to initiate.

High intensity, realistic locker actions, no stupid locker leaders.

It did not take a whole watch team to get training. Individual training is a lot easier to schedule in real life.

The fast paced multiple casualties.

Lets you see the consequences of your actions, ie. securing chill water makes you lose you Aegis system.

Very realistic and stressful. Seems to fairly represent an actual damage scenario. It forces you to prioritize casualties an allot resources accordingly.

The background noise, the pictures of personnel talking to you, the many options, this all made it very realistic.

IDCTT Trainer Survey Question 12

What aspects of the IDCTT Trainer did you like the least?

Waste of paper in repeatedly printing out DC chits.

Only one scenario.

Pace of scenario.

Difficulty inputing information.

Difficulty while inputing information.

Firemain screen is too small.

Comments from post scenario reasons for kill point activation are too general.

Trying to use the DC Plates while operating the computer was difficult.

Potential for other damage control team members, who do not have this system, to go untrained.

Not being able to tell someone verbally what to do.

Not all options are clearly expressed in the Command Console's menu.

Touchscreen.

Not able to order three things at once.

Firemain control panel.

Chill water seems to be a big emphasis, and it should be, but some amount of ship specific knowledge is required to do well on the simulator, so this facet is pretty pointless unless you are going to a DDG-51.

Some options on the menu could not be initiated.

Need more drill scenarios.

Need more ship classes.

Did not drill the entire Damage Control Central watch team.

Limited options available.

Need different scenarios.

Does not train how to handle DC Central watch team.

The DCAs load is more because he has to type information into the computer while in the DC Central Trainer he is less loaded because he talks and directs.

Inaccurate information in background noise is distracting and misleading.

Method of issuing orders.

Definitely a game.

DCA does not sit at a computer, he stares at charts. If the DCA could stand and plot and order actions it would be better. This could be solved by having the DCA stand and have a computer operator input his orders.

Was not able to jumper systems.

Data input slow. Touchscreen keyboard locked up a few times. Sometimes hard to get computer to do what you want it to do.

It takes a relatively long time to input data. Even if one is familiar with keyboards, data input is slow compared to voice commands.

Could respond more quickly in a real locker. Did not like having to input every small detail, but it did make you think things out.

Only one scenario

IDCTT Instructor Survey Question 7

What aspects did you like about the IDCTT Trainer for teaching damage control problems?

Emphasized the basic sequence of damage control problems evolution i.e., set boundaries, mechanically and electrically isolate, fight fires, etc. .

It objectively allows for multiple paths to be initiated, which is difficult to replicate in the DC Central Trainer.

Ability to present identical scenarios to each DCA student.

The ability to objectively critique the DCA's actions (i.e., prevents the "No, I didn't"..."Yes, you did" scenario).

Printed message blanks.

Realism of noise and confusion that would occur during a damage control problem.

The realism, in the fleet it is very hard to reproduce the realistic pressure involved in DC scenarios.

The stress level that it creates.

Imposes very realistic level of stress on student, particularly through the amount of informant given, the manner in which the information is given, and in the time in which it is given.

Reinforces basic and advanced damage control concepts (some with immediate feedback, some with delayed feedback, i.e., ending program).

IDCTT Instructor Survey Question 8

What problems did you encounter while using the IDCTT as an instructional aid?

The program did not run in real time. It moved more like a video game than an actual scenario.

Student familiarity.

Certain situations could only be corrected by one, and only one action.

Real time versus simulator time.

Speed of input, the touchscreen frustrated students.

Touchscreen slowed DCA's responses.

Students unfamiliar with the DDG-51 Class platform.

Fairly extensive pre-brief in classroom required to fully prepare students for IDCTT.

IDCTT interface still a bit limiting (time wise).

IDCTT locks up occasionally (very seldom now).

Problems with inactive buttons on touchscreen monitor (having to explain they do not function).

IDCTT Instructor Survey Question 9

What aspects of the IDCTT Trainer would you like to see changed?

CSMC should have its own repair team that isolates and corrects chill water problems. The ship should not rely heavily on the DCA for Combat System casualties.

The DCA has to prompt too many actions. Fire and flooding boundaries, and isolation would be reported to the DCA rather than ordered by the DCA.

Increase the avenues in which the DCA may approach solutions to the scenario.

Provide feedback from the lockers in response to incorrect or improper orders.

Change touchscreen to voice recognition.

Obviously, in the future, IDCTT will ideally have multiple scenarios and multiple platforms to choose from.

More versatility. The IDCTT Trainer needs to have more scenarios and if the DCA could program IDCTT himself, it would add more.

Scenario made a little more robust by adding more options for the students to initiate various orders.

More scenarios.

IDCTT Instructor Survey Question 10

What benefits do you envision from the use of the IDCTT Trainer at the Damage Control School?

If IDCTT can be "connected" to an EOOW, OOD and CICWO Trainer to do an integrated ship training evolution, this will be a vehicle for us.

May be used as a final simulation to objectively determine a students' ability to operate under stressful conditions.

The ability to better prepare a student for the pressures and problems associated with live DC scenarios in the fleet.

It better prepares DCAs to face the stresses of real shipboard disasters.

Better preparing the DCA for the real situation.

APPENDIX C WILCOXON SIGNED-RANK TEST CALCULATIONS

Null Hypothesis: H_0: The population distribution for the IDCTT Trainer and DC Central Trainer performance scores are identical.

Alternative Hypothesis: H_a: The population relative frequency distribution of the IDCTT Trainer performance scores is shifted to the right of the DC Central performance scores.

Data:

T^+ = Rank sum of the positive differences
= 353

T^- = Rank sum of the negative differences
= 143

n = 31

Note: Table contains the difference and rank scores for 32 student participants

Test Statistic: z = 1.99 (calculated from below equation)

$$Z=\frac{T^{+}-[n(n+1)/4]}{\sqrt{n(n+1)(2n+1)/24}}$$

Rejection Region: Reject H_0 if $z \geq z_\alpha$

z = 1.99

z_α = 1.96 at the .025 significance level

Conclusion: Reject the null hypothesis at the .025 significance level. The distribution of performance scores for the IDCTT Trainer is higher then the distribution of performance scores for the DC Central Trainer.

TABLE 17: STUDENT TRAINER SCORES

Student	IDCTT	DC Central	Student	IDCTT	DC Central
1	94	83	17	88	91
2	72	88	18	95	93
3	87	88	19	82	83
4	83	85	20	87	79
5	88	79	21	92	81
6	91	91	22	95	81
7	96	85	23	83	93
8	87	93	24	92	85
9	92	82	25	93	82
10	92	93	26	93	91
11	90	79	27	85	91
12	89	88	28	92	93
13	77	88	29	99	88
14	93	85	30	82	81
15	81	79	31	98	85
16	97	93	32	94	93

TABLE 18: IDCTT AND DC CENTRAL TRAINER WILCOXON RANKINGS

Student	Difference	Rank	Student	Difference	Rank
1	11	25	17	-3	12
2	-16	31	18	2	9.5
3	-1	4	19	-1	4
4	-2	9.5	20	8	17.5
5	9	19	21	11	25
6	0	None	22	14	30
7	11	25	23	-10	20.5
8	-6	14.5	24	7	16
9	10	20.5	25	11	25
10	-1	4	26	2	9.5
11	11	25	27	-6	14.5
12	1	4	28	-1	4
13	-11	25	29	11	25
14	8	17.5	30	1	4
15	2	9.5	31	13	29
16	4	13	32	1	4

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